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ABSTRACTS

of recent published material on Soil and Water Conservation

Number 38

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ARS 41-75-14 Issued April 1966

The "ABSTRACTS of recent published material on Soil and Water Conservation" are issued at irregular intervals. Their purpose is to bring together a summary of current published information about soil and water conservation work. Reprints of abstracted articles are generally not available in the Soil and Water Conservation Research Division. Request for reprints should be sent to the authors or institutions; addresses are appended.

The classification of articles follows the table of contents used for the "Soil and Water Conservation Research Needs" of the Soil Conservation Service. Abstracted articles are not editorialized and the language of the author is used wherever possible. In foreign articles, the units of measure are converted to usual American units. Tables are included where they help to present the information. When the entire number of a publication is devoted to reviewing one subject then the entire publication is abstracted as one article giving title and authors of each paper included in the publication. Abbreviations of journals and addresses follow U.S.D.A. Misc. Pub. 765, July 1958.

This is the 38th of the publications issued by the SCS or ARS under this title. Numbers 1-15 and numbers 17, 19, 24, and 25 are out of print.

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Authors of articles and reports in the field of soil and water conservation are urged to supply abstracts, reprints, or copies to the abstractor:

Charles B. Crook, Soil and Water Conservation Research Division, Agricultural Research Service, U.S. Department of Agriculture, Plant Industry Station, Beltsville, Maryland, 20705.

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WATERSHED ENGINEERING

Watershed Development

SEE ALSO 19, 31, 33, 35.

1. Ludwig, H. F., Meron, A., and Whisler, E. COMPREHENSIVE PLANNING FOR WATER AND SOIL CONSERVATION IN CALIFORNIA WATERSHEDS. Trans. ASAE 7(3): 218-223. 1964.

A comprehensive plan for conservation of soil and water resources in the Aliso Creek watershed was developed by the San Juan Capistrano Soil Conservation District. This measure was expected to influence all future developments in the watershed, as the area continues to become more urbanized, regardless of the diversity of the particular interests associated with individual projects. The plan should help realize maximum preservation of soil and water resources for meeting agriculture, recreation, forestry, wildlife, and urban needs.

Detailed consideration of the climate and hydrology of the watershed, soil characteristics, the water resources situation (both for ground and imported suface supplies), land use (present and future), and "outdoor" values (forestry, wildlife, and recreation) were included. A plan was developed which delineated specific conservation works and measures which should be undertaken, together with estimates of their costs, a suggested priority for scheduling of these improvements, and discussion of feasible methods for financing.

Engineering-Science, Inc., Arcadia, Calif.

Hydrology

SEE ALSO 1, 48.

2. Ackermann, N. L., and Sridurongkatum, P. SALT-WATER INTERFACE NEAR A FRESH-WATER CANAL. J. Hydraul. Div., ASCE 90 (HY 6): 97-116. Nov. 1964.

An investigation was made of the fresh-water wedge produced by the seepage from a canal which traversed a semi-infinite, isotropic, porous medium originally saturated with salt water. The canal had a rectangular cross section with impervious side walls that extend below the channel bottom. The seepage rate from the canal, and the geometry of the interface dividing the fresh-water wedge from the surrounding salt water, were determined analytically as a function of the depth of water in the canal and its geometry, the permeability of the medium, and the specific weights of the salt and fresh water. These functional relationships were presented graphically using the results of numerical computations performed on an IBM 1620 electronic computer. The accuracy of the analysis was confirmed experimentally by tests conducted on an electric analog model.

SEATO Grad. Sch. Engin., Bangkok, Thailand.

3. Hamilton, H. L., and Stelly, M. Eds. RESEARCH ON WATER. ASA Sp. P. No. 4, 121 pp. $1.50. 1964.

The following papers presented at the symposium on research on water were given:

4. Brady, N.C. FORWARD.

5. Browning, G. M. WATER IN AGRICULTURE—SIGNIFICANCE OF THE SYMPOSIUM.

6. Wadleigh, C. H. FITTING MODERN AGRICULTURE TO WATER SUPPLY.

7. Staple, W. J. DRYLAND AGRICULTURE AND WATER CONSERVATION.

8. Raney, W. A. WATER RESEARCH AND AGRICULTURE IN HUMID AREAS.

9. Phelan, J. T. RESEARCH PROGRESS AND FUTURE NEEDS IN FARM USE OF IRRIGATION WATER.

10. Bellport, B. P. ENGINEERING RESEARCH ON WATER STORAGE AND TRANSMISSION.

11. Frank, B. NEW CONCEPTS IN WATERSHED MANAGEMENT ON FOREST AND RANGE LANDS.

12. van Bavel, C. H. M. WATER AND WEATHER.

13. Thompson, L. M. OUR RECENT HIGH YIELDS—HOW MUCH DUE TO WEATHER?

14. Gardner, W. H. RESEARCH FOR MORE EFFICIENT WATER USE: SOIL PHYSICS.

15. Burton, G. W. THE GENETICIST'S ROLE IN IMPROVING WATER-USE EFFICIENCY BY CROPS.

16. Zelitch, I. THE EFFECT OF CONTROL OF LEAF STOMATA ON TRANSPIRATION.

17. Ackermann, W. C. A NEW LOOK AT WATER RESOUCRES RESEARCH.

For sale by Soil Sci. Soc. Amer., 677 Segoe Rd., Madison, Wis., 53711

18. Hely, A. G. AREAL VARIATIONS OF MEAN ANNUAL RUNOFF. J. Hydraul. Div., ASCE 90 (HY 5): 61-68. Sept. 1964.

The determination of areal variations of mean annual runoff is complicated by the phenomena of ground water outflow from individual drainage basins and channel losses. Because of these phenomena, the runoff per unit area, computed from streamflow data, may differ markedly for different locations of stream-gaging stations, independent of any difference in average precipitation on the drainage basins.

Improved definition of the areal variations in some regions may be achieved by increasing the number of gaging stations, provided that they are located where ground water outflow and channel losses are relatively small, and provided that each drainage basin has relatively uniform hydrologic characteristics. Improved definition in some other regions may be achieved by use of supplemental information, such as infiltration data and rainfall-runoff relations.

Even with the best possible network of gaging stations and optimum use of supplemental data, detailed definition of runoff isograms for large sections of the United States probably will not be possible.

Available runoff data often are not suitable for detailed definition of areal variations in mean annual runoff. Although some improvement in definition may be achieved by increasing the number of stream-gaging stations that are properly located with respect to changes in hydrologic characteristics of the drainage basins and by use of supplemental data, the detained variations in many areas probably must remain indeterminate. For such areas, figures of unit runoff at specific points shown on a map may be useful, or at least informative.

To avoid misuse or misinterpretation of a runoff map, the compiler should describe its basis and its limitations in considerable detail and expain anomalies. Small-scale maps usually indicate the contributions of large areas to major streams or other bodies of water and may be different from large-scale maps showing unit runoff from smaller areas.

Geol. Survey, U.S. Dept. Int., Yuma, Ariz.

19. Allis, J. A., Dragoun, F. J., and Sharp, A. L. TRANSMISSION LOSSES OF LOESSIAL WATERSHEDS. Trans. ASAE 7(3): 209-212, 217. 1964.

From this study, it was concluded that valley transmission losses of precipitation excess developed on watersheds of about 1 to 8 square miles can be sufficiently large that they may significantly reduce outflow floods from such watersheds. Reductions in the order of 30 percent may occur on the larger watersheds and 5 to 10 percent may occur on smaller ones.

Flood-flow reductions of these magnitudes, if not considered in the derivation of synthetic flood series from rainfall, soil and land-use data, could result in overestimates of flood peaks and volumes. This overestimate will cause overdesign of such structures as road culverts and bridges, grade-stabilization structures, and principal spillways and floodwater-storage capacities of floodwater-retarding reservoirs. Such overestimates of floods could materially affect economic studies (flood damages, flood-prevention benefits, and costs of flood-prevention structures) in watershed-planning activities.

Transmission losses in alluvial valleys of flood runoff may also materially affect water yields from watersheds of these sizes. Neglecting to consider such transmission losses could result in overestimates of water yields for such purposes as conserving water for domestic and livestock use, small municipalities, recreation, and fish and wildlife.

Transmission losses in valley alluviums characteristic of the Central Great Plains are large enough to warrant the research effort necessary to more thoroughly investigate this phenomenon and seek ways and means of reducing such losses in water-deficient areas of the country where water yields are inadequate to meet present and anticipated water needs.

F. J. Dragoun, SWCRD, ARS, USDA, Hastings, Nebr., 68901

20. Marston, R. B., and Whipkey, R. Z. NATURAL WATERWORKS. Ohio Woodlands 2(3): 4-5. 1964.

Research has shown that forest land is just about the best natural regulator of water. This is especially true in areas such as Ohio where the major goal in water management is to prevent flash floods in headwater areas.

For any given storm, it doesn't rain as hard, as fast, or as much in the woods as it does in an open field.

Studies with simulated rainfall showed that soils under a good stand of timber could absorb as much as 5 inches of water per hour. So surface run-off, which is a major contributor to flash flooding, is just about nil from wooded land.

Studies in northeastern Ohio showed that of nearly 7 inches of rain that fell during a 12-day period, only a little more than 1 inch was added to streamflow immediately. The heaviest storm totaled 2.9 inches, but only 0.18 inches ran off as streamflow that day. However, during these 12 days much water was stored in the ground and ground water flow increased 10-fold from 8,100 gallons per day to 82,000 gallons per day. Thus, the storms had the primary effect of recharging the soil moisture and ground water storage instead of producing floods.

Central State Forest Expt. Sta., FS, USDA, Columbus, Ohio.

21. Skau, C. M. INTERCEPTION, THROUGHFALL, AND STREAMFLOW IN UTAH AND ALLIGATOR JUNIPER COVER TYPES OF NORTHERN ARIZONA. Forest Sci. 10(3): 283-287. 1964.

Interception as related to gross precipitation and canopy density was studied in the Utah juniper (*Juniperus osteosperma* (Torr.) Little) and alligator juniper (*J. deppeana* Steud.) types on Beaver Creek watershed in north-central Arizona. The canopy camera provided the best index of canopy density. Interception was computed by subtracting stemflow and throughfall from gross precipitation. Stemflow was negligible. Throughfall was predicted with reasonable accuracy for either species by the equation Y = 0.044+0.865 (gross precipitation in inches) – 0.216 (canopy density index as a decimal fraction of 1.0000).

Rocky Mountain Forest and Range Expt. Sta., FS, USDA, Fort Collins, Colo.

22. Voigt, G. K., and Zwolinski, M. J. ABSORPTION OF STEMFLOW BY BARK OF YOUNG RED AND WHITE PINES. Forest Sci. 10(3): 277-282. 1964.

Measurements taken during 21 rainstorms indicated considerable differences in the capacity of *Pinus resinosa* and *P. strobus* to retain stem-flow water. Further field and laboratory measurements enabled estimation of stem and crown retention of rain water. A plantation of 38-year old pine may retain 0.03 inches or more of rainwater. About 40 percent of this retention occurs in the bark of the stem. The comparable value for white pine was about 0.02 inches.

Yale Sch. Forestry, New Haven, Conn.

23. Rhoades, E. D., Locke, L. F., Taylor, H. M., and McIlvain, E. H. WATER INTAKE ON A SANDY RANGE AS AFFECTED BY 20 YEARS OF DIFFERENTIAL CATTLE STOCKING RATES. J. Range Mangt. 17(4): 185-190. 1964.

Water relations for a Pratt loamy fine sand on the Southern Plains Experimental Range in northwestern Oklahoma were investigated after four levels of continuous cattle grazing had been imposed for 20 years. Water-intake rates were determined with a sprinkling infiltrometer and with a double ring infiltrometer. The following measurements were obtained from each level of grazing: Soil moisture retention; bulk density; penetration resistance; organic matter; nitrogen content; vegetative cover, and basal cover.

Water-intake rates were inversely proportional to the grazing intensity, regardless of the type of equipment used to approximate intake rates. There was a high correlation between the intake rates measured with the sprinkling infiltrometer and the double-ring infiltrometer; however, the intake rates with the double-ring infiltometer were about two to three times greater than those with the sprinkling infiltrometer.

Bulk density and penetrometer measurements showed that grazing compacted the soil. The heavily grazed sites retained about 0.5 inch more water in a 4-foot profile than did the nongrazed sites.

Soil organic matter and nitrogen content decreased as depth of soil increased, but neither organic matter nor nitrogen content was significantly affected by stocking rate.

Soil loss in the runoff water and in the splash from the sprinkling infiltrometer tests was negligible, even on the heavily grazed sites.

A soil-protecting cover of about 6 tons of standing vegetation and litter per acre was found on the nongrazed sites, and 2 to 3 tons were found on the grazed sites. Quantity of vegetative cover, both living and dead, and range condition class were correlated with the water-intake rates. The short, sod-forming grasses predominated under heavy grazing and tall bunch grasses predominated on the nongrazed sites.

SWCRD, ARS, USDA, Chickasha, Okla., 73018

Geology

SEE ALSO 27, 28, 30, 32, 33, 36, 44, 67, 72, 80, 175, 243.

24. Smerdon, E. T. EFFECT OF RAINFALL ON CRITICAL TRACTIVE FORCES IN CHANNELS WITH SHALLOW FLOW. Trans. ASAE 7(3): 287-290. 1964.

The effect of simulated rainfall on the erosion of the bed of a channel was determined in a research flume with a rainfall simulator. Critical tractive force values were determined for five soils.

The critical tractive forces changed very little as a result of intense rainfall on the shallow flow (less than 0.4 ft. deep). In general, the values of critical tractive force increased slightly when rainfall was present, indicating that rainfall reduced the tendency for the flow to erode the channel bed. In all cases, flow was shallow channel flow, not sheet flow.

The mean velocity of the flow was reduced by rainfall and the amount of reduction was greater for the shallow depths. The vertical velocity gradient was affected by rainfall with the velocity of the upper regions of flow being reduced more than the flow near the channel bed. This indicated that rainfall provides some resistance to the flow at the air-water interface which possibly accounts for the apparent decrease in shear at the channel bed as measured by bed erosion. This decrease in bed shear from rainfall is not considered when the tractive force is calcualted by the Du Boys equation.

The suspended sediment transport capacity was reduced by rainfall on shallow flowing channels. The reduced suspended sediment transport concentrations extended through the entire depth of flow but may have been slightly more pronounced right at the surface of the flow. The reduced suspended sediment transport capacity caused by rainfall may cause deposition of sediments if the stream is transporting heavy loads of suspended sediment.

Tex. A&M U., College Station, Tex.

25. Beverage, J. P., and Culbertson, J. K. HYPERCONCENTRATIONS OF SUSPENDED SEDIMENT. J. Hydraul. Div., ASCE 90 (HY 6): 117-128. Nov. 1964.

The occurrence of extremely high suspended-sediment concentrations is rather common to several streams in the semiarid southwestern United States. Data were presented for forty-four streamflow samples that exceed 40 percent sediment by weight. Various aspects of high concentrations were examined briefly, including particle-size distributions, clay-fraction mineralogical analyses, the sediment volume concentration relation, and the suspension mechanism. The authors concluded that:

1. The magnitude of hyperconcentrations was not related directly to the discharge of the stream.
2. The particle-size distributions of the Paria River samples were mixtures of two rather constant subdistributions: (1) of material finer than 0.062 mm.; and (2) of material coarser than 0.062 mm.

3. The proportion of sand increased with increasing concentration although there was an apparent minimum fine material concentration of about 15 percent by weight.
4. Mineralogical analyses of the clay fractions showed mostly montmorillonite and illite with some kaolinite and calcium carbonate, indicating that chemicals in solution affected the properties of the water-sediment mixture.
5. The volume occupied by the sediment became appreciable at high concentrations and should be recognized for informed water management.
6. The nature of hyperconcentrated suspensions was best desribed by a compromise view including the physicochemical effects, the damping of turbulence, lubrication by the fine material and water, and some type of dispersive force acting between the moving grains.

Geol. Survey, U.S. Dept. Int., Albuquerque, N. Mex.

26. Christensen, G. F. GUIDES FOR CONTROLLING SEDIMENT FROM SECONDARY LOGGING ROADS. Intermountain Forest & Range Expt. Sta. Unnumbered Guide, 42 pp. 1964.

The manner in which secondary forest roads are built and where they are located in watersheds have important effects on the quality of water in streams. Experience and research have shown that the relations between roads and sedimentation of streams are not simple. Such factors as geology, soils, topography, vegetation, and climate influence these relations tremendously.

Numerous practical measures, including the use of berms, surfacing, surface drainage structures, and outsloping, have been employed to reduce erosion on roads and prevent sediment from reaching streams. Despite use of such preventive measures, erosion of road surfaces and fill slopes and movement of sediment from roads into streams continue on many of our timber sale areas.

Prospects for increased timber harvesting and other uses of forest land emphasize the need to understand how to locate and build the roads needed to serve these uses without causing undue damage to soil and water resources.

The guides in this handbook are from recent research and experience. They provide a basis for understanding how and where roads may be built safely under varying conditions of soil, topography, and vegetative cover.

The following location and design rules were given for reducing erosion on logging roads: (1) Roads located on south- and west-facing slopes require more intensive measures for preventing erosion than roads on north- and east-facing slopes; (2) keep roads far enough away from streams; (3) hold to low road grades; (4) build the narrowest road that will do the job consistent with safety; and (5) build water drainage structures as part of the road construction.

The following construction and maintenance rules were given for reducing erosion:

1. Complete the grading and drainage on all sections of newly built road before fall rains begin.
2. Surface all roads built on highly erosive soils.
3. Do not allow low point of grade break to occur on deep fills if possible.
4. Leave berms on all deep fills.
5. Leave berms on climbing roads except at drainage outlets.
6. Construct down spouts over unstable fills and unstable natural slopes.
7. When maintaining roads, leave the toe of the cut slopes and the berms intact.
8. Where necessary, alter the spacing of surface drainage structures enough to spill the water on stable areas.
9. Install drainage diversion on outsloped roads.
10. Windrow unmerchantable logs and slash from road right-of-way timber along the toe of the fill slopes.

Intermountain Forest & Range Expt. Sta., FS, USDA, Odgen, Utah.

SEE ALSO 2, 18, 24, 182.

27. Herbich, J.B., and Shulits, S. LARGE-SCALE ROUGHNESS IN OPEN-CHANNEL FLOW. J. Hydraul. Div., ASCE 90 (HY 6): 203-230. Nov. 1964.

The most common measures of open-channel roughness, namely Manning's n and Chezy's C, are predicted from experience. Attempts to provide a more quantitative, less intuitive method of determining these coefficients have been confined mainly to roughness heights that are a small fraction of the depth. Submerged flow was studied in which the height of roughness elements varied from 0.53 to 1.0 times the depth to submerged flow in which elements protruded through the surface.

In a laboratory investigation, systematic relationships did exist among the Manning's roughness coefficient n (or resistance coefficient $K = 1.49/n$), Reynolds Number, Froude Number, and a special quantitative parameter of the roughness pattern. This parameter, Θ, relates the projected area of the roughness elements in the direction of mean flow to the horizontal area of the channel. The relationships, presented in graphical form, permit prediction of the depth of flow for channels having symmetric or random distribution of uniform and nonuniform roughness elements.

Prediction of the resistance coefficient, K, may be made for open channels with symmetric and relatively random distribution of uniform and nonuniform size cubical roughness elements. The prediction was based on the values of resistance coefficient, K, obtained for channels with cubes arranged symmetrically. This conclusion was particularly significant, because it permits field applications.

No scale effect existed between two geometrically similar channels with large roughness elements when the Froude law of similitude was applied.

U. Calif., Berkeley, Calif.

28. Yotsukura, N., and Fiering, M. B. NUMERICAL SOLUTION TO A DISPERSION EQUATION. J. Hydraul. Div., ASCE 90 (HY 5): 83-104. Sept. 1964.

A semi-implicit numerical solution to the differential equation of dispersion in a two-dimensional open channel was developed. Some of the details of the iterative technique and the cumputer solution were shown. The results for turbulent flows showed that the longitudinal distribution of solute concentration approaches a Gaussian (normal) pattern as the dispersion time progresses, and the dispersion coefficient depends jointly on the convective transport and on the turbulent diffusivity. These results provide a rational basis for evaluating the pattern of concentration in the transient phases between the insertion of a slug of solute and its ultimate normal pattern. The substantial computing requirement removes the technique from the realm of practical solutions; it is instead an attempt to explain a heretofore unclear hydraulic phenomenon.

Geol. Survey, U.S. Dept. Int., Washington, D.C.

29. Brock, R. R., and Krammes, J. S. A STUDY OF TRAPEZOIDAL FLUME MODELS AT SAN DIMAS. U.S. Forest Serv. Res. Note PSW-50, 12 pp. 1964.

Rating curves applicable to small and large flume installations were presented in which approach velocity permits a hydraulic control to exist. The accuracy to be expected from these curves was tabulated and plotted against field observations. The rating curves should be considered only indicative of the actual flow rates when applied to runoff containing appreciable debris quantities. Criteria were given for modifying field installations, without a hydraulic control at the flume inlet.

Pacific Southwest Forest & Range Expt. Sta., FS, USDA, Berkeley, Calif.

30. Gwinn, W. R. WALNUT GULCH SUPERCRITICAL MEASURING FLUME. Trans. ASAE 7(3): 197-199. 1964.

The Walnut Gulch supercritical measuring flume was developed for measuring the flow in detritus-laden ephemeral streams of southwest United States. This flume has curved entrance walls to provide a smooth transition from the stream channel to the straight measuring section. A 3 percent floor slope maintains velocities high enough to prevent sediment deposition in the flume. Sensitivity needed for low-flow measurement was obtained by a V-shaped floor. Capacity requirements were met by sloping the side walls of the measuring section 1-on-1. Each flume was custom designed to fit the site and was calibrated by model tests. Observations on two field instrallations, one with a 6,000 c.f.s. capacity and the other with a 18,500 c.f.s. capacity, have indicated highly satisfactory performances.

SWCRD, ARS, USDA, Stillwater, Okla., 74074

31. Overton, D. E. MATHEMATICAL REFINEMENT OF AN INFILTRATION EQUATION FOR WATERSHED ENGINEERING. U.S. Dept. Agr., Agr. Res. Serv. 41-99, 11 pp. 1964.

Holton's (1961) infiltration equation for watershed engineering was mathematically refined to obtain analytical time distributions of infiltration. The original equation was derived from the average of a series of events on plots. The refined equation was predicated on expressing the variables from event-to-event on each plot in search of an expression of Holtan's original concept. The newly derived time distributions were applied to the original data and some examples of the degree of fit were shown. These equations were then algebraically compared with some of the classical analytical infiltration equations derived from applied physics.

SWCRD, ARS, USDA, Rm. 133, Adm. Bldg., P.I.S., Beltsville, Md., 20705

32. Shanholtz, V. O., and Holtan, H. N. COMPUTER PROGRAM USHL NO. 2 WATER SURFACE PROFILES FOR SPATIALLY VARIED FLOW IN NATURAL CHANNELS. U.S. Dept. Agr., Agr. Res. Serv., ARS 41-101, 38 pp. 1965.

In a cooperative study, the U.S. Hydrograph Laboratory reviewed a number of existing hydraulic and hydrologic programs for IBM 1620 digital computers to see if any of them might be adapted to the watershed project formulation needs of the SCS and hydrologic research needs in ARS watersheds. A program developed by the U.S. Army Corps of Engineers for computing water surface profiles by the step method (1959) was selected and modified to spatially vary flow concordantly with drainage area, thus providing the profiles for selected flows-per-unit-area.

Spatial variations in flow and drastic differences in cross sections of the upland watershed streams used for trial runs caused the computed profiles to undulate unrealistically. A review of results indicated that undulations were greatest in reaches having steep slopes. The program was further modified to interpolate hydraulic elements for theoretical cross sections at predetermined vertical intervals. Spatial variation of flow was also graduated by interpolating flow between cross sections in the ratio of the accumulative interval to the total interval of elevation. By these means the water surface profiles were stabilized in close conformity with profiles computed by more sophisticated techniques.

A discussion of the method and operation instruction was given along with a description of the symbols used.

Some of the computer input data and a detailed flow diagram of the computer program were presented in the appendix.

SWCRD, ARS, USDA, Room 133 Adm. Bldg., P.I.S., Beltsville, Md., 20705

33. Holtan, H. N., and Overton, D. E. NUMERICAL EXPERIMENTS IN GENERATING AND ROUTING WATERSHED RUNOFF. Trans. ASAE 7(4): 402-408. 1964.

The computer program was applied in hydrologic computations for Hurricane Creek, a tributary to Six Mile Creek near Paris, Ark. Six Mile Creek is one of the pilot watersheds having a SCS protection program, installed in the middle 1950's.

A series of computations for Hurricane Creek was designed to portray trends in results induced by variations in assumptions for the immeasurables. Validity of these assumptions was judged by their effect on derived hydrographs as indicated by comparisons with hydrographs observed at two streamflow-measurement stations on Hurricane Creek. The trends derived may serve as aids to the hydrologist in adjusting his initial assumptions for more rapid convergence on the hydrograph facsimile. If these assumptions and techniques can be verified by comparison of derived and computed hydrographs for a range of storms, the computer may be used to study optimization of the watershed program.

Of all the decisions and assumptions that were necessary in the application of this computer program, five stood out as most emphatic in their influence on the resulting hydrographs. These were: (1) The rainfall-run-off relationship; (2) the time to peak for the unit graph; (3) the time increment for tabulations and computations; (4) the travel time for a given reach; and (5) the theoretical point of entry by local inflow to the reach. Automation permitted the many computations necessary to portray trends induced by variation in each assumption.

The authors concluded that no broad, far-reaching conclusion could be drawn from one application of this technique. However, certain computational phases were repeatedly applied to varied subareas within the watershed to the extent that their responses to inserted parameters were well demonstrated.

The facility of the computer now permits exploration of new ideas before the inspiration becomes cold or diluted by makeshift procedures. Several phases need new concepts; the routing technique in particular needs overhauling. Repetitive routing through fractional storage may provide the much needed loop curve of storage-flow relations.

SWCRD, ARS, USDA, Beltsville, Md., 20705

34. Shane, R. M., and Lynn, W. R. MATHEMATICAL MODEL FOR FLOOD RISK EVALUATION. J. Hydraul. Div., ASCE 90 (HY 6): 1-20. Nov. 1964.

A probability model was developed for use in the statistical analysis of partial-duration data. It was necessary to make some assumptions in the derivation of this model, hence care must be taken in its application so that these assumptions are not violated. In particular, for large watersheds, the assumption that the peaks occur randomly in time is likely to be violated.

In regions of the United States in which flood peaks are caused by both heavy rainfall and snowmelt, the assumption that all peak magnitudes are identically distributed is not likely to be true because the peaks are generated by two different sets of physical processes. Finally, it is necessary to use a unit time interval of 1-year, because the expected rate of occurrence of hazard events, λ, generally would not be constant for unit time intervals of less than 1-year. For the same reason, the recurrence interval, T, is restricted to integer values 0,1,2,...

This theory provides a theoretical basis for the commonly used technique of plotting the estimates of the expected recurrence interval for various discharge levels on semi-log paper and fitting with a straight line. It is hoped, that it can also be used to develop more rigorous statistical procedures for evaluating flood risk. The method presented for obtaining estimates of the design equation parameters from the sample moments was considered to be a first step in this direction. This model was also shown to be applicable to the analysis of rainfall records associated with storm sewer design.

Cornell U., Ithaca, N.Y.

35. Hanson, T. L., and Johnson, H. P. UNIT HYDROGRAPH METHODS COMPARED. Trans. ASAE 7(4): 448-451. 1964.

The effects of storm pattern, storm duration, and synthetic hydrograph method on the peak discharge and the corresponding period of rise for storm hydrographs were studied. Six watersheds, varying in size from 5.4 to 39.3 sq. mi., were involved; two were located in Iowa, two in Illinois, and two in Ohio. A constant infiltration rate of 0.10 in. per hour was used in the determination of excess rainfall for the selected storm patterns. The authors concluded that:

1. For longer storm durations, all unit graph methods tended to give better predictions of the peak discharge.
2. The longer the storm duration, the greater was the percent variation in the peak discharge and period of rise for the given storm patterns.
3. No storm pattern was consistent in giving the maximum peak discharge for the given infiltration assumption.
4. Gray's method and the SCS method were not consistent in overpredicting or underpredicting the period of rise and peak discharge when storm hydrographs based on unit graphs from recorded runoff were used as the standard.
5. Snyder's method was a poor predictor of peak discharge and period of rise for small watersheds.

The variations of predicted peak discharges and period of rise that may result from the use of three synthetic unit-graph methods, if it is assumed that the correct volume of runoff is known was indicated. With the addition of other infiltration assumptions, the confidence in prediction is further decreased. There remains an urgent need for research on the interrelationships of watershed characteristics and runoff phenomena and for development or refinement of hydrologic design procedures for convenient use by practicing engineers.

Iowa State U. Sci. and Tech., Ames, Iowa

36. Emmett, W. W., and Wallace, J. R. ERRORS IN PIEZOMETRIC MEASUREMENT. J. Hydraul. Div., ASCE 90 (HY 6): 45-61. Nov. 1964.

Engineering investigations of fluid flow in open channels usually require the measurement of piezometric head. Often the measurement is made by recording the pressure at a piezometer opening on the wall or floor of the channel. An accurate interpretation of the measurement depends on a knowledge of the performance of the piezometer and of the characteristics of the flow being measured. A laboratory investigation was conducted to study the accuracy of piezometric depth measurements in open channels. Influences of boundary geometry and flow characteristics on the piezometric measurements were evaluated.

The results of over 3,000 observations indicated that piezometric measurements of depth were characterized by positive errors that increase with size of piezometer opening. For a given piezometer size, the error was expressed as a constant percentage of the mean velocity head. Roughnesses added to the test channel tended to reduce the magnitude of the error, while mechanically generated surface waves did not influence the piezometric measurement. Other influences on piezometric measurements, incidental to the main purposes of the investigation, were revealed by the experimental data and were presented.

Water Resources Div., Geol. Survey, U.S. Dept. Int., Washington, D.C.

37. Bianchi, W. C., and Haskell, E. E., Jr. FIELD MEASUREMENT OF SOIL WATER MOVEMENT DURING ARTIFICIAL GROUND-WATER RECHARGE. Trans. ASAE 7(3): 341-343. 1964.

Because the intake rates on these plots were so low, the importance of the observations made was in the prediction of how layered profiles react if flow is limited within the profile or at the surface. The uppermost limiting layer caused flow to be unsaturated beneath it and controlled percent saturation of lower layers to great depth. Lower unsaturated fine-textured layers controlled, to a lesser degree, the saturation of layers above and below them.

The nuclear scattering methods for moisture content and wet density coupled with piezometers provided sufficient information to define what zone in the deep profiles limited flow and to make first approximations of the vertical recharge rates as determined from the rate of accumulation above the wet front. From the measurements of the surface intake rate and this vertical recharge rate, estimates of the area over which the latter rate is effective at the water table can be calculated.

The vertical recharge rate and the area associated with it at the water table are important boundary conditions in any evaluation of ground-water-mound shape theory. Another condition is the fillable pore space above the rising water table. The foregoing observations indicate that the water table will rise into an unsaturated zone associated with the above area and differing in percent saturation from the zone outside this area. The voids yet unsaturated with this area will also be a function of the texture and layer sequence within and above the zone of rise.

Any theoretical analysis of ground-water-mound dissipation should provide for the significant amount of intransit storage present in these deep profiles after surface water is removed from the recharge area. The rate of release of this storage is time dependent and of long duration.

SWCRD, ARS, USDA, Fresno, Calif., 93726

WATER MANAGEMENT

Irrigation

SEE ALSO 9, 60, 61, 62, 63, 64, 65, 67, 68, 69, 70, 71, 72, 74, 116, 155, 183, 185, 214, 248, 261, 266, 268, 272, 285.

38. Wiser, E. H., and van Schilfgaarde, J. PREDICTION OF IRRIGATION WATER REQUIREMENTS USING A WATER BALANCE. 6th Internatl. Cong. Agr. Engin. II: 121-129. 1964.

A water balance was used to predict the number of irrigations and the seasonal amount of irrigation water necessary to avoid a water deficit on a probability basis. The balance, consisting of a daily accounting of precipitation and evapotranspiration, was carried out continuously for a 25 year period.

An important difference between this and other balance procedures was the manner in which moisture was assumed to move into and out of the soil. A total soil moisture capacity was specified. Precipitation was assumed to wet the soil to field capacity, the depth of penetration depending on the amount of precipitation and the antecedent moisture content. Evaportranspiration was assumed to take place only from the wettest soil horizon. This model resulted in a series of layers at different moisture contents decreasing with depth.

Evapotranspiration was determined from temperature records using the Thornthwaite procedure, with the additional assumption of a linear decrease in evapotranspiration with a decrease in moisture content of the wettest layer from field capacity to oven dry. Any precipitation beyond that sufficient to satisfy the total soil moisture capacity was designated excess.

An irrigation was scheduled for each day when the initial soil moisture content was less than one half the total capacity. The amount applied was always one half the total capacity.

Balances were determined for 33 stations in North Carolina, using a digital computer. The results were expressed in terms of the dates on which irrigations were applied. These enabled the determination of the probability of the need for a given number of irrigations in any one year, or in any one season. Similarly, a probability could be assigned to any amount of irrigation water required per season. Using the data of all the stations studied, maps could be prepared to show either the number of irrigations or the irrigation water requirement for a specified soil moisture capacity and a specified probability level.

The calculations were made for four soil moisture capacities. Presented are the results for one of the 33 stations for all four storage capacities and one map for a storage capacity of 3 inches and a probability level of 1 year out of 10. It was noted that, at low probability levels, the curves for irrigation requirements tended to converge, so that one map for one storage capacity would permit reasonably accurate predictions for a wide range of soil conditions.

Agr. Expt. Sta., N.C. State Col., Raleigh, N.C.

39. Thompson, C. B. IRRIGATION WATER REQUIREMENTS IN TEXAS. J. Irrig. and Drain. Div., ASCE 90 (IR 3): 17-40. Sept. 1964.

The derivation of irrigation water requirements was outlined and its use for project planning work in Texas was explained.

Data were presented relative to effective precipitation, consumptive use, farm waste and deep percolation losses, canal and lateral losses, return flows, and diversion requirements. The steps used in developing diversion requirements and return flows were described, and an explanation of their use and of land inventory data was given. Cultural practices used in the production of rice were such that the application of effective precipitation and the computation of diversions for other crops were not applicable. Thus, diversion requirements for rice were explained separately.

U.S. Agency for Internatl. Develop., Kumasi, Ghana.

40. Carreker, J. R., Sparrow, G. N., and Stansell, J. R. ESTIMATING IRRIGATION WATER REQUIREMENTS FOR TOBACCO. Trans. ASAE 7(3): 262-263. 1964.

Irrigation is used by many tobacco growers and other farmers throughout the Southeast. A simple method is essential to determine when irrigation applications are needed and how much water will be required to produce a crop.

Research data at Tifton, Ga., showed that with tobacco irrigation, the average daily rate of moisture use was about 0.20 in. per day from late May until the middle of July. Without irrigation, the average daily rate of moisture use declined from 0.20 in. per day in early June to 0.11 in. per day in July.

The ratio of evapotranspiration from crops to evapotranspiration equivalent of solar radiation (E_t/R_8), determined through research at one location, can be used within reasonable limits to estimate the rate of moisture use and water requirements of crops at another location where values of R_8 are available. Application of the E_t/R_8 ratio for tobacco at Tifton, Ga., to known R_8 values at Greensboro, N.C., showed the estimated daily rate of moisture use at Greensboro was 0.17 in. on May 31, 0.19 in. on June 30, and 0.16 in. on August 31. The predicted water requirement for the 3-month period of May 31 to August 31 was 16.62 in.

SWCRD, ARS, USDA, Athens, Ga., 30601

41. Hagood, M. A. IRRIGATION SCHEDULING FROM EVAPORATION REPORTS. Wash. Inst. Agr. Sci. Ext. C. 341, 6 pp. 1964.

An irrigation scheduling board and record was given that can be used to schedule surface or sprinkler irrigations in areas where daily reports from an evaporation station are available through newspapers or radio stations.

To use the scheduling board, determine the amount of water to be applied at each irrigation and the equivalent amount of evaporation. Daily and accumulative evaporation can be marked on the scale; or put a rubber band around the board and slide it up to the accumulative evaporation reading. Rains under 0.5 inches can usually be ignored in irrigation scheduling. To account for heavier rains, move the mark for the next irrigation up the scale the amount of the rainfall.

Irrigation scheduling from evaporation reports can be started at any time during the irrigation season for perennial crops. With annual crops, this method is usually started when the foliage nearly covers the ground.

Ext. Serv., Inst. Agr. Sci., Wash. State U., Pullman, Wash.

42. Groskopp, M. D. SPRINKLER IRRIGATION OF SANDY SOILS IN CENTRAL WISCONSIN. Sprinkler Irrig. Assoc. 1964 Open Tech. Conf. Proc.: 65-69. 1964.

A report was given on sprinkler irrigation on sandy soils in central Wisconsin. The author concluded that:

1. Supplemental irrigation of vegetable and field crops was practical and profitable on the sandy soils of Central Wisconsin.
2. Evapo-transpiration studies provided useful information for more efficient irrigation of all crops.
3. Net radiation measurements coupled with determination of the percentage of crop cover was a dependable estimate of evapo-transpiration.
4. Field irrigation tests plus evapo-transpiration measurements provided reliable data for designing efficient irrigation systems.

Hancock Expt. Farm, U. Wis., Hancock, Wis.

43. Holmen, H., Schaack, J. M., and Strand, R. I. INFILTRATION OF WATER INTO POTENTIALLY IRRIGABLE SOILS. N. Dak. Farm Res. 23(5): 16-19. 1964.

Spring cultivation of irrigated alfalfa improved the infiltration rate during the first subsequent irrigation. On later irrigations, the infiltration rate reverted to the rate of the noncultivated plots. The infiltration rate was not measurably reduced by haying traffic when the moisture content was well below field capacity level.

The intake rate on irrigated sugarbeets increased with an increase in the size of furrow stream, but the size of the runoff stream increased more than the intake rate. Consequently, the percentage of the furrow stream that infiltrated into the soil decreased as the size of the furrow stream was increased.

The infiltration rate changed from time to time, especially under various crop management practices. Land in irrigated sugarbeets showed an increase in the rate of infiltration over the rate measured on alfalfa during the previous year. After the alfalfa was plowed, the restrictive layer was destroyed and the intake improved when the land was planted to sugarbeets.

N. Dak. Agr. Expt. Sta., N. Dak. State U., Agr. and Appl. Sci., Fargo, N. Dak.

44. Tovey, R. ALFALFA GROWN AS INFLUENCED BY STATIC AND FLUCTUATING WATER TABLES. Trans. ASAE 7(3): 310-312. 1964.

Use of water by alfalfa growing under high water-table conditions was studied to determine the irrigation requirement. The results presented were relative quantities measured under controlled experimental conditions and should be considered as such when applying this information to actual field conditions.

High water tables, carefully managed, can be an asset to forage crop production when water-table fluctuations are controlled. Where physical and economic conditions are favorable, drainage may be the answer. If it is not feasible to drain certain areas, good crop production can be obtained by careful water-management practices.

A summary of pertinent findings of the alfalfa static water table experiment were:

1. A three-season average of consumptive use and yield of alfalfa disregarding soil textures, showed an almost straight-line relationship with water-table depth for the non-irrigated treatment.
2. The non-irrigated alfalfa definitely showed the effects of static water-table depth on the consumptive use and yield of alfalfa, as no error was introduced by surface-water application.
3. Peak consumptive-use occurred when the alfalfa was at or approaching the one-tenth bloom stage and temperatures were high.
4. Only minor differences in the growth of alfalfa were found for the various water table, soil, and irrigation treatments.
5. The alfalfa plants in the lysimeters showed good root development, with roots in the saturated zone and enlarged white rootlets extending below the water-table level.

Significant results of the fluctuating water-table study were: (1) Excess water must be removed from the root zone of alfalfa plants adapted to 2-ft. static water tables within 3 days to insure optimum crop production; and (2) alfalfa root-system deterioration became progressively worse as the fluctuation or submergence intervals exceeded 4 days.

SWCRD, ARS, USDA, Reno, Nev., 89507

45. Shockley, D. G., Woodward, H. J., and Phelan, J. T. A QUASI-RATIONAL METHOD OF BORDER-IRRIGATION DESIGN. Trans. ASAE 7(4): 420-423, 426. 1964.

Three types of border irrigation have been defined and described by Shockley. These are level, graded, and guide. A quasi-rational method of design for the graded type was presented.

In the graded border method of irrigation, an attempt is made to adjust the size of the irrigating stream to the intake characteristics of the soil, the slope of the border strip, and the area to be covered so as to provide a nearly uniform time of water coverage (intake opportunity time) at all points along the length of the border strip. Another criterion is that the water be applied at a rate that will provide a minimum intake opportunity time approximately equal to the time required for the desired amount of water to infiltrate into the soil.

Since the hydraulic characteristics of border irrigation have not been adequately determined, it is not possible to develop a completely rational design procedure. However, a rational design to satisfy soil intake—stream size—border area—application depth relationships can be developed when certain empirical hydraulic relationships are assumed to be valid.

E & WP Work Unit, SCS, USDA, Portland, Oreg.

46. Hall, W. A. FUNCTIONAL ANALYSIS OF LEVEES FOR BORDER IRRIGATION SYSTEMS. Trans. ASAE 7(4): 396-397, 401. 1964.

A proposal was presented for the design of levees for border irrigation, applicable to the "flat ridge" border levee. There was also proposed an operating procedure for use where the design equations would specify virtually no freeboard.

To design, using this procedure, an evaluation must be made of the maximum slope for erosion tolerance with very shallow flow and of the capillary transmission characteristics of the soil. This is an addition to the usual infiltrometer data, roughness, slope, unevenness, etc., required for the design of the check itself. Where these characteristics are applicable, considerable improvement in productivity and in ease of farming operations should result. Where other problems exist, not treated in the analysis, experimental evidence of suitability of the design and operating procedures proposed should first be obtained.

U. Calif., Los Angeles, Calif.

47. Howell, D. T. NONUNIFORMITY AND SPRINKLER APPLICATION EFFICIENCY. J. Irrig. and Drain. Div., ASCE 90 (IR 3): 41-53. Sept. 1964.

Nonuniformity in the application of water by irrigation sprinklers can be expected to affect the application efficiency. The effects of nonuniformity were isolated in an application efficiency factor. The manner in which this factor varies was explored for the following three special cases: (1) When the greatest precipitation is less than or equal to that required to bring the full root zone depth to field capacity; (2) when the mean depth of application is just sufficient to bring the full root zone depth to field capacity; and (3) when the application has been increased to the extent that the minimum depth encountered is just enough to bring the full root zone depth to field capacity.

The application efficiency factor depended on the mean application ratio (which is unity for case two) and on the ratio of the sum of deficiencies measured at sampling points over the irrigated area to the sum of the depths of application measured at the same sampling points.

With numerical examples, the relationships between application efficiency factor, mean application ratio, and Christiansen uniformity coefficient were shown graphically and were seen to be affected by the skewness of the distribution of application depth.

U. New South Wales, Manly Vale, New South Wales, Australia.

48. Davis, J. R. DESIGN OF IRRIGATION TAILWATER SYSTEMS. Trans. ASAE 7(3): 336-338. 1964.

Tailwater flow from a farm irrigation system may be an economically sound practice, depending on automation considerations and the availability and cost of water and labor. Tailwater must be removed from the field and depending on water supply, water costs, and availability of drains, either reused or removed from the farm area.

A design for efficiently reclaiming tailwater flow from a farm irrigation system can be effected, based on runoff estimates. The design must consider the necessary sump size and the desired flexibility in the return system. On the average, the cost of collecting tailwater for reuse was 2 to 3 dollars per acre-foot.

Return-flow systems represent a good potential for the conservation of water and labor resources. Each designer should consider these systems in planning for the optimum use of these resources in farm irrigation systems.

U. Nebr., Lincoln, Nebr.

49. Dalrymple, R. S. ALUMINUM GOES UNDERGROUND. Sprinkler Irrig. Assoc. 1964 Open Tech. Conf. Proc.: 73-83. 1964.

A report was given on the use of aluminum pipe for buried irrigation systems along with the SCS Standards for buried aluminum pipe.

Petroleum Tech. Div., Reynolds Metals Co.

50. Fang, K. SUBMERGENCE, NPSH AND CAVITATION OF MODERN IRRIGATION PUMPS. Trans. ASAE 7(3): 332-335. 1964.

Modern irrigation pumps are exclusively of the centrifugal type (conventional centrifical pumps, mixflow pumps, propeller pumps, and deep well turbine pumps), the nature of which makes it advantageous to run at higher speed in order to cut down weight and cost. High-speed pump operation may induce cavitation problems and the NPSH (net positive suction head) data required by the pump is necessary to determine the minimum submergence or maximum suction lift to avoid cavitation. Required NPSH data furnished by pump manufacturers should be obtained by actual tests as calculated values are not sufficiently accurate. The closed-loop method is the most reliable way of testing. From various literature and the author's tests, some important factors, such as σ, S, Cm_1, U_1, β_1, etc., which affects NPSH, were described. These factors will assist in extrapolating NPSH data and in avoiding cavitation damage.

Deming Div., Crane Co., Salem, Ohio.

51. Lunin, J., Gallatin, M. H., and Batchelder, A. R. EFFECTS OF SUPPLEMENTAL IRRIGATION WITH SALINE WATER ON SOIL COMPOSITION AND ON YIELDS AND CATION CONTENT OF FORAGE CROPS. Soil Sci. Soc. Amer. Proc. 28(4): 551-554. 1964.

Dilutions of synthetic sea water were used for supplemental irrigation on small plots containing alfalfa, Kentucky 31 Fescue, orchardgrass, and ladino clover. One treatment irrigated with nonsaline water and a nonirrigated control were also included.

Significant increases in yield due to irrigation were obtained in only a few instances during the second through fourth year of study. During the first year, two of the four cuttings of all four crops responded to supplemental irrigation.

Where several irrigations were applied, yields tended to decrease with increasing salinity, with ladino clover being the most sensitive of the four crops tested. Soil salinity increased to EC_e values as high as 15.4 mmho. per cm. (electrical conductivity of the saturation extract) as a result of saline irrigation.

The Ca, Mg, and K content of all four crops were relatively unaffected by soil salinity. The Na content of all plants tended to increase with increasing salinity, with the greatest accumulation occuring in the ladino clover. Exchangeable Ca decreased and Mg, Na, and K increased with increasing salt concentration of the water applied.

SWCRD, ARS, USDA, Norfolk, Va., 23501

52. Gerber, J. F., and Harrison, D. S. SPRINKLER IRRIGATION FOR COLD PROTECTION OF CITRUS. Trans. ASAE 7(4): 464-468. 1964.

Sprinkler irrigation can be used successfully for cold protection if sufficient water is used. A general theory which estimates the amount of water required based on the lowest anticipated temperature and the wind speed was presented with field data which supported its validity. The drop size used was too small for most efficient use of the heat in the water. The result of deficient sprinkling was to increase cold damage by elevating the killing temperature of the citrus leaf and by depressing the temperature below ambient.

The important parameters in determining the required rate of sprinkling are the wind speed and the anticipated minimum temperature of a dry leaf. This temperature is not known precisely but is less than air temperature and should be measured for best results.

In order to obtain uniformly good results, water distribution must be uniform and adequate which would be reflected in a value $\propto$ which was not variable. If irrigation is to be used successfully for cold protection, either the rate of sprinkling must be variable or the minimum temperature and wind speed expected must be known and used as design criteria for the system. Once sprinkling has begun in citrus, it cannot be stopped until air temperatures are again above the danger point.

U. Fla., Gainesville, Fla.

53. de Lis, B. R., Ponce, I., and Tizio, R. STUDIES ON WATER REQUIREMENT OF HORTICULTURAL CROPS, I. INFLUENCE OF DROUGHT AT DIFFERENT GROWTH STAGES OF POTATO ON THE TUBER'S YIELD. Agron. J. 56(4): 377-381. 1964.

For growing potatoes, restrictions in irrigation at different periods of the vegetative cycle produced a decrease in tuber yield for all the treatments compared to the check, with the exception of those planted without preseeding irrigation. Statistical results showed that drought treatment from stolonization to the beginning of tuberization gave significant differences as related to the check. Apparently the variety "White Rose" passed through the most critical water requirement period during this stage.

Vegetal Biol. Inst., U. Cuyo, Mendoza, Argentina.

54. Fulton, J. M., and Findlay, W. I. CUMULATIVE EFFECTS OF SUPPLEMENTAL IRRIGATION ON FERTILIZER REQUIREMENT, YIELD AND DRY MATTER CONTENT OF EARLY POTATOES. Amer. Potato J. 41(10): 315-318. 1964.

A significant increase in yield of potatoes resulting from irrigation water applied to a highly fertile soil did not alter the fertilizer requirement of the current crop. Irrigation did not increase the fertilizer requirement in the first year and this may have been due to the very high levels initially present. Continued use of supplemental irrigation water produced higher yields and accelerated depletion of soil phosphorus and potassium so that ultimately the fertilizer rate necessary for maximum yield was greater for the irrigated than the non-irrigated crop. In previous work conducted at new sites each year, potatoes had not responded to fertilization. By repeating the experiment at the same site each year the fertilizer rate necessary to maintain maximum yield was 400 pounds 5-10-13 per acre per year for the non-irrigated and 1,600 pounds for the irrigated crop.

The dry matter content of the fifth-crop tubers was not influenced by the application of irrigation water. Unfertilized plots produced tubers with higher dry matter content than plots fertilized with 800 or 1,600 pounds of 5-10-13 per acre. However, the improvement in dry matter content was accompanied by a yield reduction of 150 bushels per acre on the unirrigated and 250 bushels per acre on the irrigated plots.

Res. Sta., Res. Br., Canada Dept. Agr., Harrow, Ontario, Canada.

55. Hanson, E. G., and Knisel, W. G. INFLUENCE OF IRRIGATION PRACTICES ON COTTON PRODUCTION AND FIBER PROPERTIES. N. Mex. Agr. Expt. Sta. B. 483, 34 pp. 1964.

Three irrigation experiments were conducted near University Park, N. Mex., with two varieties of cotton (1517 C and Pima S1) on two different soils (deep, fine to medium textured soil and shallow, medium to coarse textured soil).

Irrigation treatments ranging from 17.8 to 38.8 inches of water per season caused significant differences in plant heights in all experiments, but only on the finer soil were there significant differences in yield of lint cotton.

All experiments included check treatments in which plants were stressed for moisture before the bloom stage and in varying degrees from slight to severe wilting later in the season. Fiber tests from these check treatments showed trends mainly toward coarser, stronger, more uniform, and more mature fibers than those from the treatments in which there was no appreciable stress for moisture.

Fine- to Medium-Textured Soil—The highest yield on the finer soil was produced with 4-inch post-planting irrigations which were started about June 15 and continued at approximately 15-day intervals through the first week in September. Including the preplanting irrigation, the average seasonal water application for this treatment was 30.8 inches. In this treatment, the land was irrigated when 80 to 90 percent of available moisture was depleted from a depth of 6 to 12 inches below the ground surface. The plants wilted only slightly before irrigation during the period of greatest water use. This treatment produced 1188 pounds of lint cotton per acre, 129 pounds more than a check treatment which received about the same amount of irrigation water but was stressed early in the season.

Medium- to Coarse-Textured Soil—On the coarser soil, the yield from the stressed check treatments were not significantly different from those under more frequent irrigations. The postplanting irrigations for these check treatments were begun about the end of June and continued at 17- to 20-day intervals until the end of the first week in September.

With 1517 C, the highest amounts of water, 28.6 to 31 inches, produced lint yields of 727 to 798 lb./A. The check treatments, receiving less water, 17.8 to 22.8 inches, produced yields of 694 to 759 lb./A.

With Pima S1, results were similar to the 1517 C experiment in that some of the yields from the stressed treatments were as good as the treatments which were not stressed.

Check treatments on the coarser soils were allowed to wilt for 4 to 5 days during the fruiting period without significantly lowering the yield. This indicates that farmers waste water when they schedule their irrigations to minimize wilting of cotton in sandy "hot spot" areas of their farms.

The irrigation treatments on the coarser soil had greater influence on the fiber characteristics of 1517 C than on those of Pima S1.

There were no important differences between cotton grown on single beds as compared to double beds.

Paired Irrigation Treatments—Treatments receiving light irrigations were paired with treatments receiving heavy irrigations to evaluate the influence of variable amounts of irrigation water applied due to unlevel or poorly-graded land. The treatments in each pair were irrigated with the same frequency. Differences in seasonal application within pairs of treatments ranged between 8 and 12 inches of water and resulted in significant differences in some plant and fiber characteristics in all experiments, and in yield on the finer soil.

Tables and charts.

Agr. Expt. Sta., N. Mex. State U., State College, N. Mex.

56. Long, R. B., and Stephens, W. P. PUMP IRRIGATION COSTS, CURRY COUNTY, NEW MEXICO. N. Mex. Agr. Expt. Sta. Res. Rpt. 100, 9 pp. 1964.

Curry County is located in east-central New Mexico. The irrigated area is the southeastern portion of the county. Recently there has been a heavy development of irrigation in the area.

Wheat and sorghum are the two major crops grown on irrigated land. Irrigation in Curry County tends to be more supplemental than in other New Mexico counties because rainfall is adequate in some years. The annual precipitation averages from 16 to 18 inches, but droughts are common.

Pump irrigation water is not easily obtained in the Clovis area. Wells up to 500 feet deep and lifts averaging 300 feet are typical. Water quality is good and pump yields average about 700 gallons per minute.

Deep wells and great lifts require large investments for Curry County irrigators. Investments for the well, casing, pump, motor, and accessories varied from $8,600 to $23,700 and averaged about $13,300.

Annual per acre-foot pumping costs averaged $9.86 for the 38 study farms. Costs per acre-foot for all natural gas plants averaged $8.58, while they were found to be $12.86 and $13.68 for butane and diesel fuel respectively. Natural gas, however, was not practical for all farms in Curry County because of the pipeline cost. On one farm, the natural gas lines cost $5,000. On farms with very high pipeline costs diesel or butane fuels would be more economical.

The average total cost per acre-foot was the lowest for plants pumping between 400 and 500 acre-feet per season.

Tables and photographs

Agr. Expt. Sta., N. Mex. State U., State College, N. Mex.

Drainage

SEE ALSO 26, 48, 74, 117, 148.

57. Luthin, J. N. THE DRAINAGE OF SLOPING LAND. 6th Internatl. Cong. Agr. Engin. II: 169-175. 1964.

The problem of the drainage of sloping land was analyzed for a special case. Boussinesq's equation was presented and a solution of the equation for the case of equally-spaced ditch drains on a hillside was given. The ditches were assumed to reach to the impermeable layer. It was assumed that the waterlogged zone was being replenished at a constant rate. The soil was assumed to have a uniform hydraulic conductivity and the ditches were at right angles to the impermeable layer.

A graph was presented for calculating the ditch spacing for a given rate of replenishment from the information given.

The solutions obtained by Schmid and Luthin were then compared to a solution obtained with the Hele-Shaw viscous flow model. It was shown that the results obtained by the two different methods were comparable.

U. Calif., Davis, Calif.

58. Fouss, J. L., and Schwab, G. O. RESEARCH ON PLASTIC-LINED MOLE DRAINS IN THE UNITED STATES. 6th Internatl. Cong. Agr. Engin. II: 150-158. 1964.

During the past 15 years, various methods have been developed in the U.S. for the installation of plastic tubes in more drain channels to provide low-cost subsurface drainage. In the early research, these channels were stabilized with prefored and perforated polyethylene plastic tubes pulled into the mole channel behind the mole plow. In later developments, a drain laying implement was attached to the mole plow. A continuous roll of sheet plastic was fed through the device and into the mole drain, thus forming either a circular or arch-shaped mole liner.

In 1960, mole-lining equipment was developed which guided a 0.015-inch thickness polyvinyl chloride (PVC) plastic strip into the mole channel and "zippered" the edges together by a series of interlocking tabs prestamped along the top of the 3-inch (7.6 cm.) diameter plastic drain. During installation, a soil compaction device, which was attached rigidly behind the mole-lining tool, closed the slit left by the mole plow blade. Field studies have shown that the slit closure operation was very important to drain durability. To be effective the thin-walled, flexible-type plastic mole liner should be completely surrounded with compacted soil.

The zippered plastic-lined mole drain was tested and compared with simple overlay-type circular mole liners (edges of the plastic strip overlapped but not joined or bonded) and arch-shaped liners in several field experiments under various soil and climate conditions. After 3 years in a heavy clay soil, the zipper plastic mole liners maintained the drain channel size and shape better than other types of plastic liners. Outflow from the plastic drains was nearly the same as from conventional 4-inch tile.

An automatic grade-control system was developed for the floating-beam-type mole plow which was used to pull the mole-lining implement. The automatic leveling device maintained the plow frame at a constant slope (nearly parallel to the drain gradient) regardless of the ground-surface topography. A fluid-dampened pendulum served as the sensing device for slope changes. Installation speeds up to 125 feet-per-minute at depths of 33 inches were successfully obtained in heavy clay soils. The cost of the complete installation was estimated at 12 cents per linear foot, including plastic material.

SWCRD, ARS, USDA, Columbus, Ohio.

59. Edminster, T. W. DEVELOPMENTS IN EQUIPMENT AND MATERIALS FOR SUBSURFACE DRAINAGE. 6th. Internatl. Cong. Agr. Engin. II: 142-149. 1964.

The high cost of materials, labor, and machine time for installation of conventional clay and concrete tile has resulted in a critical study of means of providing effective, lower-cost subsurface drainage.

Techniques for "formed-in-place" installation of plastic sheeting or foil have been widely studied and reported. While highly successful, under many soil and use conditions, limitation in load bearing capacity has prompted study of alternative materials and methods.

A thin, 0.008-inch steel sheet coated with a flexible porcelain for corrosion protection may provide satisfactory load-bearing resistance, when closure and installation techniques have been fully developed.

A spiral-wound, perforated, plastic ribbon enveloped in a fiberglass filter mat and supported by an internal spiral-wound, corrosion-protected, reinforcing wire also shows promise, both in reducing weight and in facilitating forming and installation.

An interlocking "tongue-and-groove" plastic ribbon formed by spiral winding into a tubular form shows a potential for high load-bearing capacity. Currently, its use is limited to industrial application; however, it has possibilities for adaptation to drainage.

Recent patent disclosures indicate that a formed-in-place, quick-setting polystyrne plastic lining may provide for even greater weight reduction and, under certain soil and loading conditions, result in an effective mole lining technique.

These new materials and techniques represent but a preliminary sample of the potential developments possible under intensive research and development programs by agricultural engineers. There is a continuing challenge to develop techniques for reducing surveying, staking, and layout costs. Machines that will perform higher-speed installation, controlled by automatic grade-control devices, together with automatic back filling, provide further challenges.

SWCRD, ARS, USDA, Beltsville, Md., 20705

60. Hammad, H. Y. DESIGN OF TILE DRAINAGE FOR ARID REGIONS. J. Irrig. and Drain. Div., ASCE 90 (IR 3): 1-15. Sept. 1964.

The following points involved in the design of tile drainage systems for irrigated zones were investigated: The distribution of moisture in the capillary zone; the drainage and irrigation requirements; the water-table fluctuation; and the depth and spacing of tiles.

The solution gave a set of equations sufficient for the determination of the different parameters necessary for the design of tile drainage. The treatment was based on the soil properties, the quality of irrigation water, and the salt tolerance of plants.

In general, the treatment assumes uniformity and homogeneity of soil. Because this is hardly the case in practice, statistical averages should be taken for the measured soil parameters that will be substituted in the design equations given. Most essential is the permeability figures, which may vary considerably from point to point.

Alexandria U., Alexandria, Egypt, U.A.R.

61. Research Committee of the Irrigation and Drainage Division. IRRIGATION AND DRAINAGE RESEARCH CONFERENCE. J. Irrig. and Drain. Div., ASCE 90 (IR 4): 1-106. Dec. 1964.

The irrigation and Drainage Research Conference was conducted at Utah State University on March 19-21, 1964.

The purpose of the Conference was to bring together scientists, engineers, and others who are authorities in certain fields of irrigation and drainage to freely exchange ideas and knowledge. The objectives of the Conference were to delineate and stimulate research needs in selected subject fields. The advancement of knowledge and improvement of the quality of engineering in planning, design, operation, and maintenance of irrigation and drainage systems was the ultimate objective of the Conference deliberations.

Summary reports were given by the chairman for each of the six following panel discussions:

62. Harbeck, G. E. EVAPORATION FROM WATER AND SOIL SURFACES.

63. Moodie, C. D. SALINITY AND ALKALI PROBLEMS.

64. Simons, D. B. STABLE CHANNELS.

65. Phelan, J. T. SMALL, LOW-COST HYDRAULIC STRUCTURES FOR CONVEYANCE AND DISTRIBUTION SYSTEMS.

66. Elliott, R. D. WEATHER MODIFICATION.

67. Banks, H. O. GROUND-WATER MANAGEMENT.

Abstracts of the following principal addresses were given:

68. Dominy, F. E. THE OVERALL IMPORTANCE OF IRRIGATION AND DRAINAGE BOTH NATIONALLY AND INTERNATIONALLY.

69. Edminster, T. W. NEED FOR NEW AND CREATIVE RESEARCH IN IRRIGATION AND DRAINAGE.

70. Ackermann, W. C. NEED FOR COOPERATIVE EFFORT AND COORDINATION.

71. Clyde, G. D. HALF A CENTURY OF RESEARCH IN THE FIELD OF IRRIGATION AND DRAINAGE.

Amer. Soc. Civil Engin., 2500 South State Street, Ann Arbor, Mich.

72. Talsma, T. TECHNICAL AND ECONOMIC CONSIDERATIONS ON DRAINAGE OF IRRIGATED LAND, IN RELATION TO SOIL PROPERTIES AND LAND-USE PLANNING. 6th. Internatl. Cong. Agr. Engin. II: 215-223. 1964.

The requirements for drainage in humid areas differ from those of irrigated areas, where the salinity factor is taken into account. This leads to generally different drain design criteria. Where saline irrigation water is used, the design discharge coefficient is related to the leaching requirement and the leaching efficiency of the soil. This leads to discharge coefficients generally smaller than those used in humid regions. Under conditions of an unstable saline water table, the drainage depth is related to the moisture conduction properties of the soil profile; this depth is between 120-200 cm. and is greater than for humid areas.

An example was given of setting up tile drainage criteria for the Murrumbidgee Irrigation Areas in Australia. Costs of drainage systems, designed with these criteria, were related to soil permeability, depth of permeable soil, and drainge depth. Soil properties influenced drain spacing and the economics of drainage markedly: Drainage at greater depth constituted a moderate saving when soil remained permeable to great depth. Where an impermeable layer was close to tile lines, shallower drainage was more economic.

From technical and economic considerations applying to conditions in the Murrumbidgee Irrigation Areas, it was concluded that the economic limit of drainage was at soil permeability values between 9-15 cm./day for reclaiming existing farms. For future land use planning, it was suggested to set as limit for soil permeability the value of 30 cm./day.

Irrig. Res. Lab., C.S.I.R.O., Griffith, New South Wales, Australia.

Storage and Conveyance

SEE ALSO 2, 10, 18, 39, 64, 94, 293, 303, 304, 308.

73. Mateos, M. STABILIZATION OF TWO IOWA LIMESTONES WITH FLY ASH ALONE. Iowa Acad. Sci. Proc. 70: 290-294. 1963.

Fly ash has been used together with lime in the stabilization of soils. Some fly ashes were found to harden and develop strength without addition of lime. One of these fly ashes was used to stabilize two crushed limestones. After 28 days moist curing, specimens of limestone mixed with 20 percent fly ash showed water stable strengths of 400 p.s.i. The stabilization of soils with fly ashes that react without lime is one of the cheapest soil stabilization methods.

Fly ash can be bought at the power plants at about $1 per ton, while cement costs about $15 per ton at the manufacturing plant. From previous experiments with lime-fly ash stabilization, from 20 to 30 percent fly ash is needed to stabilize soils. This is from 2 to 5 times the amount of cement needed to stabilize most soils.

Project Engin., Torany Cia, Madrid, Spain.

74. Blackburn, R. D., and Weldon, L. W. CONTROL OF SOUTHERN NAIAD IN FLORIDA DRAINAGE AND IRRIGATION CHANNELS. Weeds 12(4): 295-298. 1964.

The most promising of 13 herbicides for the control of southern naiad (Najas guadalupensis (Spreng.) Magnus) were acrolein, mono-N, N-dimethylcocoamine and di-N, N-dimethylcocoamine salts of endothall, diquat, and paraquat. Acrolein and the two alkylamine salts of endothall gave the most rapid kill of southern naiad but retreatment was necessary at the end of 16 weeks. Diquat and paraquat were the two most promising materials evaluated. Large scale applications of acrolein, di-N, N-dimethylcocoamine salt of endothall, and diquat confirmed these results. Diquat and paraquat were the only herbicides of the 13 that were not toxic to fish.

CRD, ARS, USDA, Fort Lauderdale, Fla.

BASIC SOIL SCIENCE

Soil Physics

SEE ALSO 13, 23, 31, 36, 37, 38, 40, 41, 42, 43, 44, 61, 72, 89, 96, 105, 148, 150, 159, 161, 165, 187, 210, 256, 261, 266, 267.

75. Greig, J. K., Fogleman, M. E., and Wittsell, L. E. SOIL COMPACTION EFFECTS ON TRANSPLANTED TOMATOES. Proc. Amer. Soc. Hort. Sci. 85: 490-496. 1964.

Compaction of Geary sil soil to a buck density of 1.7 g./cm. reduced vine growth and marketable fruit production of tomato plants under field conditions. Soil compacted 1.6 g./cm. was not detrimental as compared to the noncompacted soil having a bulk density of 1.2 g./cm.

Tomato roots penetrated a silt loam soil compacted to a bulk density of 1.6 g./cm. to the same extent and at the same rate as roots in noncompacted soil. Significant differences between root weights by depths from banded and nonbanded transplants did not occur. Vine and fruit production were decreased when the plants were grown in soil compacted to a bulk density of 1.7 g./cm.; however, significant differences in total weight of roots at the end of the growing season did not occur. Root growth in the compacted soil apparently increased before the end of the growing season, probably because they penetrated the subsoil of less bulky density; however, vine growth and fruiting were delayed.

Roots did not penetrate soil heavily compacted 10 inches deep as readily as the other compaction treatments, under greenhouse conditions. Soil compaction affected rate of penetration more than total root growth when measured by dry weight.

Tomato plans showed no symptoms from soil compaction other than reduced growth.

Kans. State U., Manhattan, Kans.

76. Gardner, H. R., and Danielson, R. E. PENETRATION OF WAX LAYERS BY COTTON ROOTS AS AFFECTED BY SOME SOIL PHYSICAL CONDITIONS. Soil Sci. Soc. Amer. Proc. 28(4): 457-460. 1964.

The use of a wax layer for root penetration tests under controlled soil conditions has made it possible to separate, from other factors in the soil, the effect of mechanical impedance on the growth of plant roots. The penetration percentage of cotton roots increased as soil moisture tension was increased from 0.05 bar to 0.52 bar then decreased as tension was further increased to 10.8 bars. The penetration also decreased with increasing salt content in the soil solution. Decreased aeration as measured by CO_2 content also lowered the penetrating ability of cotton roots. An increase in bulk density of the soil from 1.0 g. per cc. to 1.4 g. per cc. did not affect the penetrating ability of cotton roots into the wax layer.

Nitrogen Lab., Fort Collins, Colo., 80522

77. Edwards, W. M., Fehrenbacher, J. B., and Vavfa, J. P. THE EFFECT OF DISCRETE PED DENSITY ON CORN ROOT PENETRATION IN A PLANOSOL. Soil Sci. Soc. Amer. Proc. 28(4): 560-564. 1964.

Corn root penetration studies in an Illinois Planosol (Weir sil) indicated that large corn roots were confined to the larger spaces between peds but that many medium and small roots penetrated about one-half of the total discrete peds in the claypan B horizon directly under a corn hill. A discrete ped bulk density of about 1.80 g. per cc. was the threshold density above which peds were not penetrated by roots. The minimum intraped (within ped) porosity of peds penetrated by roots was about 33 percent. Mixing the A and B horizons reduced the root restrictive effect of the A_2 horizon.

Iowa State U. Sci. and Tech., Ames, Iowa.

78. Committee on Properties of Soils and Soil Deposits. SOIL PROPERTIES RESEARCH INVENTORY. J. Soil Mechanics and Found. Div., ASCE 90 (SM 6): 25-41. Nov. 1964.

The results were given of a survey on current research on soil properties carried out by the Soil Mechanics and Foundations Division's Committee on Properties of Soils and Soil Deposits. All pertinent information brought to the attention of the Committee in response to direct correspondence and Newsletter appeals was included.

Results of the inventory were classified into 15 major research areas. A brief description of each research topic was listed as well as the name and address of the organization doing the work and a cross reference to related research areas where appropriate.

This listing should prove of value to those interested in the engineering properties of soils.

No address given.

79. Seed, H. B., Woodward, R. J., and Lundren, R. FUNDAMENTAL ASPECTS OF THE ATTERBERG LIMITS. J. Soil Mechanics and Found. Div., ASCE 90 (SM 6): 75-105. Nov. 1964.

The physical significance of the Atterberg limits was examined and theoretical relationships between the liquid and plastic limits and the clay content of a soil were developed. The relationships were shown to be in good agreement with actual test data for inorganic and organic clays.

An analysis was made to determine the relationship between liquid limit and plasticity index for organic and inorganic clays. Inorganic clays were positioned in a small zone of the plasticity chart and organic clays were in a somewhat larger, but generally lower zone of the chart. The predicted positions of the different types of clay were in excellent agreement with previous experimental determinations.

At clay contents greater than approximately 40 percent, the plasticity indices of soils containing a given type of clay was directly proportional to the clay content but this relationship was not true at lower clay contents. Thus, definitions of the activity of clays based on simple linear relationships should be used with caution.

U. Calif., Berkeley, Calif.

80. Bouwer, H. UNSATURATED FLOW IN GROUND-WATER HYDRAULICS. J. Hydraul. Div., ASCE 90 (HY 5): 121-144. Sept. 1964.

Water tables as zero-pressure surfaces do not separate saturated hydraulic conductivity from impermeability in systems of flow of water through soil. Hydraulic conductivity relationships on the negative pressure side of the water table are a property of the soil and must be experimentally determined. The various methods for obtaining these relations were examined, and curves relating hydraulic conductivity to negative soil-water pressure were shown for 28 soils. These curves, which are generally sigmoid, can be simplified to step functions for including flow at negative soil-water pressure in the analysis of steady flow systems. Such systems were then solved with a certain negative pressure (called the critical pressure head), rather than with zero pressure, at boundaries where the system is in contact with atmospheric air in the soil.

Critical pressure heads calculated for the 28 soils showed that this factor may vary from -15 cm. of water or more for sands to -100 cm. water or less for structureless loams and clays. The procedure was demonstrated for systems with mainly horizontal flow, downward flow, and for flow through restricting layers.

SWCRD, ARS, USDA, Phoenix, Ariz.

81. Brooks, R. H., and Corey, A. T. HYDRAULIC PROPERTIES OF POROUS MEDIA. Colo. State U. Hydraul. Papers No. 3, 27 pp. 1964.

Following the Burdine approach, a theory was presented that develops the functional relationships among saturation, pressure difference, and the permeabilities of air and liquid in terms of hydraulic properties of partially saturated porous media. Procedures for determining these hydraulic properties from capillary pressure—desaturation curves were described. Air and liquid permeabilities as a function of saturation and capillary pressure were predicted from the experimentally determined hydraulic properties.

The theory also describes the requirements for similitude between any two flow systems in porous media occupied by two immiscible fluid phases when the nonwetting phase is static and the flow of the wetting phase is described by Darcy's law. The requirements for similitude were expressed in terms of the hydraulic properties of porous media.

SWCRD, ARS, USDA, Fort Collins, Colo., 80521

82. Ward, J. C. TURBULENT FLOW IN POROUS MEDIA. J. Hydraul. Div., ASCE 90 (HY 5): 1-12. Sept. 1964.

An equation applicable for both laminar and turbulent flow in porous media was developed and experimentally verified. This equation expressed the pressure drop per unit length as a function of the absolute viscosity and mass density of the fluid and the macroscopic velocity. Because this equation is dimensionally homogeneous, any consistent set of units may be used.

The experimental data were represented on a plot of the Fanning friction factor for porous media versus the Reynolds number for porous media, in which the characteristic length, in both cases, was the square root of the permeability. The analogy between this plot and similar plots for circular pipes was noted together with the differences. The relationship between filtration and sedimentation was also shown. Water was the fluid used in all of the experimental runs. Glass beads, ion exchange resin, sand, gravel, anthracite coal, and granular activated carbon were the porous media used. Some of the glass beads media were approximately uniform in size.

U. Ark., Fayetteville, Ark.

83. Banks, R. B., and Ali, I. DISPERSION AND ADSORPTION IN POROUS MEDIA FLOW. J. Hydraul. Div., ASCE 90 (HY 5): 13-31. Sept. 1964.

A mathematical analysis was presented of the phenomenon of simultaneous dispersion and adsorption of a solute in porous media flow. Mathematical solutions were given that refer to the case of dispersion without adsorption and to the case of adsorption without dispersion. Numerous experiments were conducted in a lucite column containing 3 mm. or 5 mm. diameter glass beads; water was the fluid and methylene blue dye the solute in all experiments. The Reynolds number range extended from 6.6 to 280. The rate constants, introduced in the expression for solute transfer from the fluid phase to the solid phase, correlated fairly well with the Reynolds number. A dimensionless plot of all concentration data was obtained; the coordinates of this plot were predicted from the mathematical analysis. This work relates to some aspects of soil leaching and salinity intrusion problems.

SEATO Grad. Sch. Engin., Bangkok, Thailand.

84. Task Force on Use of Neutron Meters Committee on Hydrometeorology. USE OF NEUTRON METERS IN SOIL MOISTURE MEASUREMENT. J. Hydraul. Div., ASCE 90 (HY 6): 21-43. Nov. 1964.

The results of a survey on the use of neutron scatter devices in soil moisture measurement were presented. A questionnaire distributed by the Task Force in 1962 requested information on applications of the radioactive method and equipment, its effectiveness, and the problems encountered. Some information was obtained also on gamma ray scattering devices used for soil density determination.

The survey responses, although limited in number, indicated a representative sampling of uses and problems. The portable nuclear equipment available in 1964 provides a simple, rapid, and effective means for nondestructive measurement of moisture and density at depth and at the surface. Equipment malfunction problems, common during the developmental years, have been overcome to the point that reliable operation can be expected. Results obtained with depth equipment, particularly for moisture, appear more satisfactory than those from surface observations.

The general principles, equipment available, and the variety of applications in hydrologic studies, construction, and agriculture were reviewed, a summary of advantages, disadvantages, and problems was given. Depth-moisture equipment is used most extensively in hydrologic and agricultural studies, but both surface-moisture and surface-density equipment are used in construction activities. The nuclear equipment generally gives integrated values for soil volumes larger than those used in standard tests. Questions of interpretation and equivalence of results have delayed acceptance of the nuclear method in lieu of standard test procedures in construction; however, use of the equipment for "on-th-spot" checking and selection of sites for standard testing appear to be growing. The report concludes with a large selected bibliography.

No address given.

85. Skidmore, E. L., and Stone, J. F. PHYSIOLOGICAL ROLE IN REGULATING TRANSPIRATION RATE OF THE COTTON PLANT. Agron. J. 56(4): 405-410. 1964.

The existence of a physiological role in regulating transpiration rate was investigated. The study was conducted in a growth chamber using Acala 44 cotton as a test plant. The transpiration rate decreased in the afternoon with no change in environmental conditions. The decrease in transpiration could not be explained by environmental factors. It was deducted that a physiological role must be operative in causing a reduction in transpiration.

Impedance of roots to water absorption was studied as a possible cause of the decrease in transpiration rate. Root impedance was measured by the volume of water absorbed by excised roots under a suction of 38 cm. Hg. Approximately five times as much water was absorbed by roots excised at 11 a.m. than roots excised at 8 p.m. The conclusion was that the root impedance to water absorption increased between 11 a.m. and 8 p.m. An increase in root impedance undoubtedly caused a decrease in transpiration rate.

Late in the day when root impedance was high, the transpiration rate was cyclic. The plant was unable to supply sufficient water to the leaves to meet the demands for evaporation and the plant wilted. The wilting of the plants was attended by a closing of the stomata. When the stomata closed, the transpiration rate was greatly reduced and the plants regained turgor. As the plants became turgid again the stomata opened and the transpiration rate increased again.

Transpiration rate in response to physiological saturation deficit was evaluated at 1 and 8 p.m. (daylight for this study was 8 a.m. to 8 p.m.). Physiological saturation deficit (PSD) was defined as the difference between water vapor pressure at the temperature of the leaf and vapor pressure in the ambient atmosphere. At the earlier time, transpiration rate was directly proportional to PSD, but at the later hour, when root impedance was high, an inverse relationship existed. Behavior of water flow was similar to electron flow in an electric circut with capacitive reactance and delayed feed-back making up a portion of total impedance.

Although transpiration rate may be controlled largely by environmental factors, physiological factors within the plant play an important role in regulating transpiration rate. It is untenable to assume that root impedance to water absorption remained constant throughout a given day.

SWCRD, ARS, USDA, Manhattan, Kans.

86. Lane, R. K. ESTIMATING EVAPORATION FROM INSOLATION. J. Hydraul. Div., ASCE 90 (HY 5): 33-41. Sept. 1964.

A previously developed equation correlation evaporation and insolation quantities with air temperature for a local region was recomputed from a wider geographic distribution of data. This more general equation estimated evaporation with correlation coefficients as high as those found when estimating evaporation with individual station equations. This equation was suitable for estimating monthly totals of pan or shallow basin evaporation and yearly totals of lake evaporation (with the use of a 0.92 coefficient).

Harvard U., Cambridge, Mass.

Soil Chemistry and Minerology

SEE ALSO 23, 102, 103, 105, 106, 110, 112, 113, 114, 115, 116, 120, 121, 123, 129, 133, 136, 137, 140, 150, 152, 154, 163, 164, 168, 172, 173, 207, 212, 251, 305, 308.

87. Salmon, R. C. CATION EXCHANGE REACTIONS. J. Soil Sci. 15(2): 273-283. 1964.

Wyoming bentonite, Blisworth illite, and a fen peat were saturated with different proportions of calcium, magnesium, and potassium. Exchange between these cations was studied by measuring their activity ratios in dilute equilibrium solutions.

With both clays, the activity ration aMg/aCa in solution was linearly related to the ratio of absorbed Mg/Ca, the former being 1.22 times larger than the latter ratio. Peat held magnesium much less strongly than calcium, and the difference increased with increasing magnesium saturation. With all three materials, the activity ratio aMg/aCa +Mg in solution was curvilinearly related to the percentage magnesium saturation. Peat absorbed potassium less strongly relative to the divalent cations than did the clays, and bentonite absorbed potassium less strongly than illite. Decreasing the Ca:Mg ratio increased the strength with which peat absorbed potassium, but had no effect on potassium absorption by the clays.

Exchange between magnesium and calcium in forty British soils was studied by measuring the concentration ratio [Mg]/[Ca+Mg] in equilibrium soil solutions. The relation between [Mg]/[Ca+Mg] in solution and the ratio of exchangeable Mg/(Ca+Mg) in different soils varied within the range covered by peat and bentonite or illite, suggesting that differences between soils might be due to different organic-matter contents. The extent to which [Mg]/[Ca+Mg] in solution was altered by changes in the exchangeable magnesium content differed considerably between soils. These differences were not all explained by variations in exchange capacity, showing that different soils adsorbed magnesium with differing strengths relative to calcium.

Rothamsted Expt. Sta., Harpenden, Herts, England.

88. Wild, A., and Keay, J. CATION-EXCHANGE EQUILIBRIA WITH VERMICULITE. J. Soil Sci. 15(2): 135-144. 1964.

The exchange of Na, Mg, Ca, Sr, and Ba ions was studied in the temperature range 25° C. - 70° C.

Vermiculite showed a preference for divalent ions over Na ions at 25° C. and the preference increased very greatly at higher temperatures. The preference was largely determined by the increase in entropy which accompanies the replacement of monovalent ions by divalent ions in the vermiculite. Preference was less marked between divalent ions. The greater affinity of Mg ions compared with other divalent ions was explained by their closer approach to the silicate surfaces.

The U. Reading, Reading, Berskshire, England.

89. Elgala, A. M., and Maier, R. H. CHEMICAL FORMS OF PLANT AND SOIL IRON AS INFLUENCED BY SOIL MOISTURE. Plant and Soil 21 (2): 201-212. Oct. 1964.

Experiments were conducted to determine whether soil moisture content has an effect on the chemical forms of plant and soil iron. Soybean plants (Lee) were grown on Adelanto loam soil under greenhouse conditions. Two different moisture levels, 75 percent and 120 percent of the moisture equivalent, were maintained in soil samples placed in individual containers. The same moisture treatments were used for separate soil samples on which the test plants were grown.

Soil iron forms were determined in the moisture-treated soil by using different extracting agents. A significant decrease in soil iron extracted with 10^{-4}M EDTA from soil at the high moisture level was attributed to a relative increase in the free calcium ion.

Soybean plants grown under the high moisture level were chlorotic while those under the low moisture level were green in appearance. Plant samples were taken at two stages of growth for subsequent analysis.

The chemical analysis of the leaf tissues showed the presence of equal amounts of total iron and less amounts of water-soluble and "active iron" in chlorotic tissues as compared to non-chlorotic tissues. The difference found between chlorotic and non-chlorotic plants in the amount of iron in the water extract was in the trichloroacetic acid-soluble fraction. The water-and salt-soluble protein nitrogen was approximately the same in chlorotic and non-chlorotic leaves.

U. Ariz., Tucson, Ariz.

90. Williams, C. H., and Steinbergs, A. THE EVALUATION OF PLANT-AVAILABLE SULPHUR IN SOILS. II: THE AVAILABILITY OF ADSORBED AND INSOLUBLE SULPHATES. Plant and Soil 21(1): 50-62. Aug. 1964.

The availability to oats of adsorbed sulphate in soils and of sulphate impurity in calcium carbonate was studied in pot-culture experiments.

When calcium carbonate was added to soils with pH values ranging from 5.7 to 7.4, the uptake of sulphur by oats was increased, due probably to enhanced mineralization of soil organic sulphur. When the calcium carbonate contained sulphate impurity, the uptake of sulphur was further increased by an amount comparable with the release of sulphate which could be expected from a reaction of the calcium carbonate with the exchangeable hydrogen of the soil. Sulphate in excess of this amount appeared to be largely unavailable. Uptake of sulphur by oats from calcareious sands containing large amounts of insoluble sulphate associated with calcium carbonate also suggested that soil sulphur in this form had very low availability to plants.

Substantial increases in the amounts of sulphur extracted by reagents commonly used for the determination of adsorbed sulphate in soils occurred when soils were airdried at about 20° C. Decreases in adsorbed sulphate in soils following the growth of oats in pot culture confirmed that adsorbed sulphate is readily available to plants.

Commonwealth Sci. and Indus. Res. Organ. Canberra, A.C.T., Australia.

91. Baker, D. E. A STUDY OF ISOTOPIC DILUTION AS A METHOD FOR RELATING PHOSPHORUS RETENTION TO AVAILABILITY OF PHOSPHORUS IN WIDELY DIFFERENT SOILS. Soil Sci. Soc. Amer. Proc. 28(4): 511-517. 1964.

Six soils considered different with respect to their release and retention of P were limed and equilibrated with P-32 and 25, 100, and 400 p.p.m. of P by alternate wetting and drying for 1 week prior to seeding Turghi millet and Tokyo buckwheat. The crops were grown under greenhouse conditions to determine if active solid phase P, as determined by isotopic dilution, could be used as an index of available P, and to determine the relationship of active solid phase P to availability of P. The authors concluded that:

1. The active solid phase P was related to the amount of available P contained in a soil, although the amounts of active solid phase P from native sources increased with rates of carrier P on all soils.
2. Plant growth and uptake of P were closely related to both the amount of active solid phase P present in soils and the concentrations of P in the soil solution.

3. Plant growth and uptake of P were related very closely to the amount of P extracted with Bray's No. 1 extracting solution. The correlations were high for amounts of P extracted by Bray's No. 2 reagent, Morgan's reagent, and water.
4. The response of plants to added P varied with plant species and soil type. Buckwheat removed a larger portion of the added P which was fixed.

It was concluded that the amount of active solid phase P contained in a soil is a characteristic which is closely related to the amount of available P. By adding 400 p.p.m. of P as a carrier for the P-32, more of the native active solid phase P equilibrated with the added P-32. The percent active solid phase P removed by Bray's No. 1 extractant was a reliable measure of the P retention characteristics of a soil if the P-32 was in equilibrium with the native active solid phase P. It was suggested that if different soil types were characterized with respect to the percent active solid phase P extracted by Bray's No. 1 extractant it would be possible to predict more accurately the amounts of P which should be added to soils to obtain desired soil test levels.

Pa. Agr. Expt. Sta., University Park, Pa.

92. Ghoneim, M. F., and Maier, R. H. DEVELOPMENT AND USE OF A SHORT-TERM NUTRIENT-ABSORPTION TECHNIQUE FOR EVALUATING SOIL MAGNESIUM STATUS. Plant and Soil 21(2): 213-230. Oct. 1964.

A greenhouse investigation was undertaken to study and evaluate the use of a short-term nutrient-absorption technique for evaluating soil magnesium status. Barley (Hordeum vulgare), variety Arivat, was used as the test plant. The investigations included four experiments with the following objectives: (1) To determine the need for base applications of nitrogen and phosphorus in a soil-magnesium study using a short-term nutrient absorption technique; (2) to study the effect of base applications of N and P on Mg-uptake by plants under three time periods of root-soil contact; (3) to study the effect of increasing soil moisture from 75 to 100 percent of the soil moisture equivalent on the plant uptake of Mg; and (4) to evaluate the short-term nutrient-absorption technique in determining the magnesium status in six different soils: Gila silt loam, Tours silty clay loam, Cajon clay loam, LaPalma fine sandy loam, Yavapai silty clay loam, and Casa Grande loam. Magnesium was applied in the form of $MgSO_4$ and Sul-PO-Mag.

Plant growth, potassium, calcium, and magnesium uptake were increased by the base application of nitrogen and phosphorus using a 7-day period of root-soil contact.

Plant growth was not affected by soil moisture level. Potassium and calcium concentrations in the plant were decreased with increasing soil moisture, but the total plant uptake of these nutrients was not affected. Total plant uptake and concentration of magnesium were increased by increasing soil moisture level.

The results agreed with previous observations that soil response to Mg does not depend upon the amount of exchangeable magnesium in the soil.

U. Ariz., Tucson, Ariz.

93. Vistelius, A. B., and Hurst, V. J. PHOSPHORUS IN GRANITIC ROCKS OF NORTH AMERICA. Geol. Soc. Amer. B. 75(11): 1055-1092. 1964.

A total of 602 determinations, including 57 new determinations, of phosphorus in granitic rocks of North America were reported. The frequency distribution of phosphorus was investigated for eight regions, the correlation between phosphorus and the major elements as well as between normative apatite and the other mineral norms for three regions, and the correlation between phosphorus and modal composition for one region.

In some cases, the observed asymmetry of frequency distributions was explained by correlation between concentration of phosphorus and variations in its distribution. In others, the asymmetry was explained by autometamorphic leaching of apatite. Examples of the former can be found in a belt which extends from Arizona via Oregon to northwestern North America. Examples that might be attributed to leaching can be found in a belt which extends from Texas to New England.

Phosphorus is a very important component of granites. Concentrations of phosphorus in granitic rocks can be correlated with mineralogic composition: The higher the quartz, the lower the phosphorus; the higher the percentage of mafic minerals, the higher the phosphorus. No correlations were observed between phosphorus and alkalies or feldspars, but a close correlation existed between phosphorus concentration and a whole set of major oxides.

Jr. Author, U. Ga., Athens, Ga.

94. Sims, J. L. NITROGEN AVAILABILITY IN RICE FIELD AND RESERVOIR SOILS. Ark. Farm Res. 8(2): 2. 1964.

The amount of available soil nitrogen present at seeding time in rice field and reservoir soils and the capacity of these soils to produce nitrogen were determined.

Approximately equal amounts of nitrate and ammonium N were found in the silt loam and clay soil groups but almost all of the available N found in the reservoir samples was in the ammonium form. Ammonium forms of N are stable in the reduced zone of flooded soils, whereas nitrate forms are not stable in this zone. Therefore, a larger percentage of the available N content of the reservoir soils could remain for use by the rice plants than would be true for the other two groups of soils.

Rice Branch Expt. Sta., U. Ark., Stuggart, Ark.

95. Gasser, J. K. R. SOME FACTORS AFFECTING LOSSES OF AMMONIA FROM UREA AND AMMONIUM SULPHATE APPLIED TO SOILS. J. Soil Sci. 15(2): 258-272. 1964.

Urea supplying 100 lb.N/A. was either broadcast on the surface or mixed with four soils (two clay-loams and two sandy-loams) and losses of ammonia were measured when the soils were maintained at 40, 50, or 60 percent water-holding capacity (WHC) and incubated at 5° or 25° C. Urea and ammonium sulphate were similarly applied to two calcareous soils at 40 percent WHC and 5° or 25° C. Losses varied most among soils, from 2 percent of the N applied from an unmanured clay-loam to 13 percent from an unmanured sandy-loam. Changing temperature and water content affected losses little on average, but their effects differed with different soils. Losses of ammonia were similar from urea and from ammonium sulphate applied to the calcareous soils. Analyses at the end of the experiments showed that: (1) Nitrite tended to accumulate in the sandy and calcareous soils, accumulation being favored by lower temperature and wetter soil; (2) Ammonia was lost at 25° C. from calcareous soils until all the ammonium-N had been nitrified, from the slightly alkaline clay soils until nine-tenths had been nitrified, and from the neutral sandy soils until half had been nitrified.

Rothamsted Expt. Sta., Harpenden, Herts, England.

96. Burns, G. R., and Dean, L. A. THE MOVEMENT OF WATER AND NITRATE AROUND BANDS OF SODIUM NITRATE IN SOILS AND GLASS BEADS. Soil Sci. Soc. Amer. Proc. 28(4): 470-474. 1964.

The movement of water and nitrate (NO_3^-) around bands of $NaNO_3$ was studied in soils and glass beads in the laboratory. A hypothesis was developed and tested concerning the predominantly downward movement of NO_3^- from a band of $NaNO_3$ in soils with moisture contents greater than field capacity. The hypothesis of events is as follows: Soil water moved, under the osmotic force generated, to the band of $NaNO_3$; then the $NaNO_3$ disolved and diffused away from the band. However, the effect of the diffusion was reduced when sufficient mobile water was present in the surrounding soil to maintain the influx of water. As a result, the $NaNO_3$ solution accumulated in the vicinity of the band. Once the accumulating solution exceeded that which could be held by the capillary forces of the soil, the excess $NaNO_3$ solution literally dropped out of the band under the force of gravity. The drop-out of $NaNO_3$ solution continued until essentially all of the $NaNO_3$ had been dissolved.

This drop-out phenomenon occurred in systems in which the water was present initially in quantities greater than field capacity, was moved through the system by leaching, or was moved into the system by capillarity from a shallow water table. Evidence supporting the details of the hypothesis resulted when various shields were used to alter the NO_3^- movement around the fertilizer bands under the leaching and "static" moisture conditions.

SWCRD, ARS, USDA, Beltsville, Md., 20705

97. Sabbe, W. E., and Reed, L. W. INVESTIGATIONS CONCERNING NITROGEN LOSS THROUGH CHEMICAL REACTIONS INVOLVING UREA AND NITRATE. Soil Sci. Soc. Amer. Proc. 28(4): 478-481. 1964.

The urea-nitrite Van Slyke reaction was studied to determine the conditions necessary for this reaction to contribute to evolution of nitrogen gas (N_2) by chemical denitrification in soils. The reaction was carried out in buffer solutions and the evolution of gases was analyzed quantitatively. The variables studied were pH, acidity, time and reactant concentrations.

Two conditions necessary for N_2 evolution under an anaerobic atmosphere from an urea-nitrite solution were: (1) A concentration of each reactant of 0.05 mg. N per ml., or greater; and (2) pH 6.0 or lower. Evolution of N_2 increased with decreasing pH and increasing reactant concentration. Nitric oxide (NO) formation was increased by increasing acidity, increasing nitrite concentration, and decreasing urea concentration. Nitrite accumulation in soils following urea fertilization required an alkaline media. Therefore, the possibility that this pathway (urea-nitrite reactions) of nitrogen loss occurs in soils was doubtful.

CRD, ARS, USDA, U. Ark., Fayetteville, Ark.

98. Coffee, R. C., and Bartholomew, W. V. AMMONIA SORPTION AND RETENTION BY PLANT RESIDUE MATERIALS. Soil Sci. Soc. Amer. Proc. 28(4): 482-485. 1964.

Investigations were conducted to measure the quantities of NH_3 physically sorbed and the quantities of sorbed NH_3 retained against evaculation by some common plant residues when exposed to NH_3 in a dry condition and with different amounts of moisture. With increases in NH_3 pressure, both moist and dry samples of each plant residue physically sorbed increasing quantities of NH_3. When saturated with NH_3, evacuated, and then saturated a second time, each dry plant material sorbed less NH_3 during the second than during the first saturation. Increases in moisture content resulted in increases in physical sorption of NH_3 across the entire range of partial pressures of NH_3 employed. Saturation of the moist plant residue samples with NH_3 resulted in some measurable increases in NH_3 content after evacuation.

Wis. State U., Platteville, Wis.

99. Coffee, R. C., and Bartholomew, W. V. SOME ASPECTS OF AMMONIA SORPTION BY SOIL SURFACES. Soil Sci. Soc. Amer. Proc. 28(4): 485-490. 1964.

Rates of sorption of NH_3 through soil surface boundaries, the extent of penetration into thin surface strata, and relative sorbing capacities of surface layers were determined for soil materials from several Coastal Plain and Piedmont soils. NH_3 sorption through soil surface boundaries was rapid from aerial applications ranging from 1.3 to 1.9 mg. NH_3-N per cm.^{2} of surface area. Specific rate of sorption was directly proportional to the concentration of NH_3 remaining above the soil surface. NH_3 nitrogen sorbed by soil in the surface strata did not penetrate more than 10-20 mm. into the soil when applied at rates ranging from 0.17 to 1.00 mg. NH_3-N per cm.^{2} of surface. The depth distribution of NH_3 changed with time of contract with NH_3 without appreciable change in total NH_3 sorbed. In general, clay soils sorbed more efficiently than sandy soils, soils with low pH more efficiently than those with high pH, and soils with high organic matter contents were less efficient than mineral soils with similar cation-exchange capacities.

Wis. State U., Platteville, Wis.

100. Hsu, P. H. ADSORPTION OF PHOSPHATE BY ALUMINUM AND IRON IN SOILS. Soil Sci. Soc. Amer. Proc. 28(4): 474-478. 1964.

A slightly acid soil was treated with dilute phosphate solutions of pH to study the mechanism of phosphate fixation. Two reactions operating at different rates were recognized. The one which proceeded more rapidly was believed to be due to surface adsorption of phosphate on the amorphous aluminum hydroxides and iron oxides already in the soil. The other, a much slower reaction, was due to the surface adsorption on similar amorphous hydroxides and iron oxides developed during the experiment. The solubilities of variscite, synthetic $Al(OH)_2H_2PO_4$, and synthetic $Fe(OH)_2H_2PO_4$ were considerably increased in the presence of this soil indicating that these compounds are not likely to be the products of fixation under these conditions.

Pa. State U., Col. Agr., Agr. Expt. Sta., University Park, Pa.

Soil Biology

SEE ALSO 116, 117.

101. Wieringa, K. T. THE HUMIFICATION OF HIGH-MOOR PEAT: II. SOIL MICRO-ORGANISMS DECOMPOSING AROMATIC COMPOUNDS, AND SYNTHESIS OF COMPLEX HUMUS-LIKE SUBSTANCES. Plant and Soil 21(3): 333-344. 1964.

Dark colored substances were formed by soil micro-organisms (Pseudomonas, Arthrobacter-Corynebacterium-Nocardia group, spore forming bacteria, and Streptomyces, from aromatic compounds, e.g. phenol, benzoic acid, guaiacol, toluene, phthalic acid, catechol, tyrosine, and tryptophane. The dark-brown to black substances formed by these organisms possess humus-like quantities and have the appearance of dopplerite.

Reducing substances reacting in the cold with triphenyl tetrazolium chloride were formed as intermediates. It was suggested that these intermediary substances were quinones, or semi-quinones and that these occur as free radicals which subsequently polymerize to humus-like substances.

Agr. U., Wageningen, Netherlands.

102. Visser, S. A. A PHYSICO-CHEMICAL STUDY OF THE PROPERTIES OF HUMIC ACIDS AND THEIR CHANGES DURING HUMIFICATION. J. Soil Sci. 15(2): 202-219. 1964.

Humic acids extracted from decomposing plant and peat core samples and changes in them during the process of humification were investigated in terms of their elementary composition, the acidity and the equivalent weight, the infra-red, visible, and ultra-violet spectra, and the shape and size of the molecules and their weight. With progressive humification in peat and decomposing plant samples, increases were noted for the carbon content and the aromatic character of the humic-acid molecules and in the number of their alcohol and ether groups, aliphatic side chains and double bonds. Decreases were observed for the hydrogen content, the molecular weight, the equivalent weight, the hydrophilic character of the humic acids, and to a minor extent for the ionization constant and the alkoxyl and alkimide groups.

The presence of charcoal and, to a minor extent, of clays in decomposing plant material promoted the formation of humic acids which were very similar to those found in older peat deposits. The presence of ash did not seem to have much effect. Humic acids derived from different peat materials were very similar in structure and composition, but when different types of plant material were mixed, the humic acids formed during the first stages of decomposition were very similar to those from more decomposed samples containing only the separate components.

Makerere U. Col., Kampala, Uganda.

103. Eno, C. F., and Popenoe, H. GAMMA RADIATION COMPARED WITH STEAM AND METHYL BROMIDE AS A SOIL STERILIZING AGENT. Soil Sci. Soc. Amer. Proc. 28(4): 533-535. 1964.

Red Bay loamy fine sand and Everglades muck were sterilized with gamma radiation, steam, and methyl bromide, Exchangeable NH_4^+; extractable N, P, and S; moisture equivalent; cation-exchange capacity; and organic matter were measured. None of the sterilization treatments significantly altered cation-exchange capacity. Steam significantly increased the amounts of N, P, and S extracted and the organic matter content values, compared to the check and the other two soil treatments; it also significantly decreased the moisture equivalent percentage. Gamma ray and methyl bromide sterilization generally increased the release of N, P, and S above the check. There was also a strong indication, based on the N data, that sterilization by gamma rays disrupted the soil organic materials more than methyl bromide. Finally, the intensity of all these factors was most closely associated with the organic matter content of the soil. Therefore, a sand, for example, would not be altered nearly as much as a loam or an organic soil.

U. Fla., Agr. Expt. Sta., Gainesville, Fla.

104. Anderson, O. E., and Boswell, F. C. THE INFLUENCE OF LOW TEMPERATURE AND VARIOUS CONCENTRATIONS OF AMMONIUM NITRATE ON NITRIFICATION IN ACID SOILS. Soil Sci. Soc. Amer. Proc. 28(4): 525-529. 1964.

The accumulation of nitrates at low temperature varied widely among several cultivated, acid soils of the Southeast to which 100 p.p.m. NH_4-N was added as NH_4NO_3. It was either completely suppressed or delayed for several weeks in the sandy soils at 42° F. But in a clay loam, though nitrate accumulation was severely retarded at 37° F., rapid accumulation occurred at 47° F. after a 6-week delay period. The effect of soil differences on nitrate accumulation was further emphisized by the fact that in the clay loam at 47° F. it was much more rapid than in a loamy sand at 90° F.

Increasing the amount of added NH_4NO_3 also delayed or completely suppressed nitrate accumulation at low temperatures in all soils, and in the sandy soils, NH_4NO_3 applied in excess of 200 p.p.m. delayed nitrification even at temperatures near optimum (90° F.). The depressive effect of both low temperature and concentration was most apparent in the loamy sand, intermediate in the sandy loams, and least in the clay loam.

Some loss or immobilization of N occurred in several instances since ammonium disappeared from the samples in small amounts without concomitant increase in nitrates and all of the added N was not recovered.

The substantial difference among these soils in their capacity to nitrify applied ammonium, not only at low but also at near-optimum temperature, emphasized the importance of the influence of individual soil characteristics on N transformations.

Because of the profound influence of both low temperature and high concentration of NH_4NO_3 on the depression of nitrate accumulation in the Norfolk loamy sand and the Clarksville sandy loam, it appears likely that banded NH_4-N would nitrify very slowly, if at all, when the soil temperature is 42° F. or lower.

Ga. Agr. Expt. Sta., U. Ga. Col. Agr., Experiment, Ga.

105. Harris, R. F., Chesters, G., Allen, O. N., and Attoe, O. J. MECHANISMS INVOLVED IN SOIL AGGREGATE STABILIZATION BY FUNGI AND BACTERIA. Soil Sci. Soc. Amer. Proc. 28(4): 529-532. 1964.

Microbial mechanisms of soil aggregate stabilization were investigated as a function of microbiological and water-stability changes of incubated artificial aggregates, 2 to 4.76 mm. in size composed of soil particles <0.5 mm., prepared from Waupun sandy loam. Aggregate water-stability was determined by wet-sieving and expressed as the percentage of soil material bound into water-stable aggregates 0.5 to 1 mm., 1 to 2 mm., and >2 mm. in size. Microbial development was investigated by dilution plate and microscopic methods.

Aggregate stabilization was a function more of microbial synthesis of soil-binding substances than of numbers of microorganisms. Extensive production of mycelium and spores in soil aggregates by a fungus known to be capable of aggregate stabilization, did not, necessarily, result in an increase in the stability of the aggregates. Stabilization of aggregates by Mucor silvaticus involved the binding of soil particles into > 2 mm. water-stable aggregates at all stages of incubation. Aggregates stabilized under anaerobic conditions exhibited a high percentage contribution of 0.5- to 1-mm. and 1- to 2-mm. aggregates to total stability in the early stages of incubation. A relatively high proportion of the total water-satability of sucrose-amended aggregates possessing the indigenous mixed microflora was attributable to stable 0.5- to 2-mm. aggregates in the early stages of aerobic incubation, an indication that bacteria were more important than fungi in the initial stabilization of these aggregates.

U. Wis., Madison, Wis.

106. Allison, F. E. FERTILIZER NITROGEN: HOW ITS EFFICIENCY IS AFFECTED BY SOIL MICROORGANISMS. Agr. Sci. Rev. 2(2): 16-23. Spring 1964.

The efficiency with which nitrogen fertilizers are likely to be utilized by crops grown under various conditions can now be predicted with considerable accuracy if the conditions are well defined. This development is largely the result of intensive research in recent years on the activities of the soil microorganisms that are responsible, directly or indirectly, for most of the nitrogen transformations occuring in soils.

Nitrogen recovery in crops, including roots, seldom exceeds about 75 percent under the most ideal conditions, as in greenhouse pots where leaching is prevented. Nitrogen tracer experiments have shown that usually half or more of the unrecovered nitrogen remains in the soil, whereas the remainder escapes as gases. Under field conditions, where leaching may occur, a recovery of 50 to 65 percent of the nitrogen in the crop, including roots, is considered very good. If only the harvested portion of the crop is considered, the recovery may be much less than 50 percent. In longtime field experiments, recoveries in harvested crops of 30 to 50 percent of the added fertilizer nitrogen have been common.

Additions of nitrogen often fail to give the expected rapid increases in plant growth and crop yields even though losses as gases, or in the drainage waters, are kept at a minimum. This disappointing response to nitrogen may be due to a variety of causes but the main reasons are likely to be either: (1) Low availability of the added nitrogen source; (2) nitrogen immobilization by microorganisms that live on crop residues or in the rhizosphere; or (3) unfavorable conditions for plant growth, including deficiencies of other essential nutrients.

A thorough discussion was given on how the efficiency of nitrogen fertilizers are affected by soil microorganisms.

The author concluded that although much has been learned in recent years about nitrogen transformations in soils and how to control them so as to increase nitrogen-use efficiency, it is also true that new problems have arisen, partly as a result of the introduction of new fertilizer materials and methods of use. Many of the old problems, especially those involving nitrogen losses from soils, have been solved only partially. Much more basic data are needed on what happens to nitrogen in soils.

Retired, SWCRD, ARS, USDA, 4930 Butterworth Place, N.W., Washington, D.C.

107. Janitzky, P., and Whittig, L. D. MECHANISMS OF FORMATION OF Na_2CO_3 IN SOILS: II. LABORATORY STUDY OF BIOGENESIS. J. Soil Sci. 15(2): 145-157. 1964.

Biological transformations have been responsible for formation of Na_2CO_3 and resultant high alkalinity in some of the salt-affected soils of the Sacramento Valley, Calif. Environmental factors favoring Na_2CO_3 formation are high ground water level to provide an anaerobic environment, supply of Na_2SO_4, and organic matter. Under these conditions, anaerobic micro-organisms reduce sulphate to sulphide and oxidize organic matter to CO_2. The sulphides hydrolyse to produce free OH which combines with CO_2 to form HCO_3. Reduced Fe in the system inactivates the sulphides and allows accumulation of $NaHCO_3$. Loss of CO_2 from $NaHCO_3$ during dry periods of the year results in formation of Na_2CO_3.

In the laboratory, an anaerobic environment and a supply of readily decomposable organic matter were shown to be essential for development of HCO_3 and CO_3. Ultimate development of high alkalinity depends upon inactivation of soluble and exchangeable divalent bases as precipitated carbonates. Inactivation of divalent bases favors a high exchangeable Na content as well as build up of soluble $NaHCO_3$ and Na_2CO_3.

There is an equivalent relationship between the amount of SO_4 reduced and HCO_3 formed by the processes involved. The anaerobic organisms involved in the transformations obtain oxygen from the SO_4 and in turn oxidize carbon of the organic matter to CO_2.

Development of HCO_3 and CO_3 is favored in situations where organic matter and Na_2SO_4 concentrations are both high, but is limited in systems with a relatively low organic matter content and a high concentration of Na_2SO_4, or conversely, when a high content of organic matter is combined with a low salt concentration.

U. Calif., Davis, Calif.

108. McCalla, T. M., and Haskins, F. A. PHYTOTOXIC SUBSTANCES FROM SOIL MICRO-ORGANISMS AND CROP RESIDUES. Bact. Rev. 28(2): 181-207. 1964.

A wide variety of phytotoxic substances exist in plant residues and seeds. Included are such compounds as amino acids, alkaloids, certain essential oils, coumarin, unsaturated lactones such as parasorbic acid, phenols and aldehydes, organic acids, ammonia, hydrogen cyanide, mustard oils, scopoletin and scopoletin glycosides, and ethylene. Soil micro-organisms also produce many organic substances which are toxic to plant growth. Examples are organic and amino acids, numberous antibiotics, and substances such as gibberellin. Toxic inorganic compounds, such as nitrites, carbon dioxide, and hydrogen sulfide, are also produced by soil micro-organisms.

Although green plants can live autotrophically, it is apparent that under suitable conditions they can also live heterotrophically, absorbing organic compounds from their surroundings and metabolizing these compounds. Plants grown in the soil are normally exposed to a tremendous variety of organic compounds which have come directly from plant and animal residues in the soil, or indirectly from these residues through the action of soil micro-organisms. Depending upon their nature and concentration, and on the kind of the plant being grown, these substances may be innocuous, stimulatory, or inhibitory to plant growth. Thus, the role of soil organic constituents in plant growth is extremely complex, and present understanding of this role is at best fragmentary, particularly for plants grown under field conditions. Nevertheless, it appears that under some chemical, physical, and biological cinditions in the field, phytotoxic substances are produced and can accumulate to such an extent that reduced plant growth results.

The presence of phytotoxic substances in plant residues and soil, and the production of such substances by micro-organisms, may account in part for adverse effects of a particular crop on a succeeding crop in crop rotations, yield reductions encountered in stubble mulching, citrus and peach tree replant problems, sod binding in bromegrass, frenching of tobacco, seedling disease of tobacco, and legume bacteria factor in chlorosis of soybeans, and inoculation failure with subterranean clover.

Tables, photographs, and bibliography of 145 papers.

SWCRD, ARS, USDA, U. Nebr. Col. Agr., Agr. Expt. Sta., Lincoln, Nebr., 68503

109. Schreven, D. A., Van THE EFFECT OF SOME ACTINOMYCETES ON RHIZOBIA AND AGROBACTERIUM RADIOBACTER. Plant and Soil 21(3): 283-302. 1964.

The antagonistic activity of 22 actinomycetes was tested against a number of rhizobium and Agrobacterium radiobacter strains on agar medium. Each kind of rhizobium reacted with a certain number of actinomycetes, whereas none of the actinomycetes exerted an antibiotic effect towards the five tested strains of A. radiobacter. The cells of Rhizobium trifolii and R. meliloti sometimes produced branched forms when th they were exposed to the action of an actinomycete. By contrast A. radiobacter cells never produced branched forms under these conditions.

Although the sensitivity of the different rhizobium strains towards the actinomycetes was found to differ considerably, all the tested rhizobium strains were sensitive towards a strain of Streptomyces scabies, S. lavendulae, and S. griseolus.

When two strains of R. meliloti were exposed five times to the activity of the same antagonistic actinomycete, in some cases, the resistance of the rhizobium cells increased. In some cases, repeated exposure of R. meliloti and R. trifolii strains to antagonistic actinomycetes resulted in the occurrence of a small number of variants producing no nodules, a smaller number of nodules, less effective nodules, or ineffective nodules on their hosts.

No clear differences were observed in the time required for decolorizing methylene blue between untreated rhizobium strains and strains which had been exposed five times to the action of some actinomycetes.

Yssel Lake Polders' Develop. and Colon. Authority, Kampen, Netherlands.

110. Powrie, J. K. THE EFFECT OF COBALT ON THE GROWTH OF YOUNG LUCERNE ON A SILICEOUS SAND. Plant and Soil 21(1): 81-93. Aug. 1964.

The nodulation and growth of young lucerne plants on a moderately acid siliceous sand were greatly increased by inoculation and the application of lime. In addition, cobalt treatment significantly increased the yield of nitrogen per nodulated plant and the amount of nitrogen fixed per nodulated plant but had no effect on non-nodulated plants. Cobalt significantly increased the fresh weight of nodules per plant, due to greater nodule size, and the amount of nitrogen fixed per unit fresh weight of nodular tissue was substantially increased. The effects of cobalt on symbiotic nitrogen fixation led to significant increases (29 to 77 percent) in the dry-matter yield of lucerne tops.

Waite Agr. Res. Inst., U. Adelaide, Adelaide, S. Australia.

111. Abel, G. H., and Erdman, L. W. RESPONSE OF LEE SOYBEANS TO DIFFERENT STRAINS OF RHIZOBIUM JAPONICUM. Agron. J. 56(4): 423-424. 1964.

The effects of (Rhizobium japonicum) strains on several growth characteristics of Lee soybeans were evaluated in field experiments at Brawley, Calif.

In fields free, or essentially free, of soybean rhizobia, some strains were more effective than others in increasing the seed yield, protein percentage of seed, root nodulation, green leaf color, and fresh plant weight, and in decreasing the oil percentage of seed. One strain was effective in one year and ineffective in another.

Single strains were not better than strain mixtures. Seven strains used in a commercial culture produced an effective inoculant.

In a soil where nodulated soybeans had grown previously, treatments involving the strains were not measurably different from the uninoculated checks.

CRD, ARS, USDA, Brawley, Calif.

SEE ALSO 51, 54, 92, 108, 166, 180, 214, 233, 282, 307.

112. Bardsley, C. E., Suman, R. F., and Stewart, E. H. THE SULFUR STATUS OF SOUTH CAROLINA CROPS AND SOILS. S.C. Agr. Expt. Sta. Tech. B. 1013, 12 pp. 1964.

The amount of sulfur brought down in rainfall at four locations in South Carolina averaged 6.7 lb./A. annually during the period December 1952 through November 1955. Values obtained the last year were generally higher than the first 2 years. Because of the unpredictable nature of this source of sulfur and because the average value falls short of the sulfur needs of most vigorous crops, this source of sulfur cannot be relied on for crop nutrition.

Seed cotton yields were significantly increased by sulfur during a 9-year period on Norfolk loamy sand. The average increase due to annually applied sulfur was 158 lb./A. per year. Response to sulfur was obtained after 2 years' use of sulfur-free fertilizer. Yields were not affected every year, but usually sulfur-deficiency symptoms were evident during some growth stage each year. One broadcast application of sulfur, as gypsum, brought an annual average increase of 214 pounds of seed cotton per year over a 3-year period. Gypsum applied at a rate to supply 64 pounds of sulfur per acre (approximately 350 lb./A.) proved to be adequate for the 3-year period studied. In contrast to this, 8 pounds of sulfur, as gypsum, proved adequate as an annual band-applied treatment.

Ladino clover and carpet grass showed response to sulfur the third year following establishment of Goldsboro fine sandy loam. Response was not evident in all cuttings but occurred mostly at the beginning and end of the summer season. These are periods when soil organic matter would be expected to contribute little native sulfur.

An experiment on a Piedmont alluvial soil, Chewacla silt loam, failed to show response to sulfur. This result was consistent with results obtained on other alluvial soils in the Southeast.

Total sulfur percentages of cotton leaves and petioles and of forage samples are indicative of low or high supplies of sulfur but may be difficult to interpret in view of dilution effects due to growth response of crops.

The acetate-soluble sulfate and bicarbonate-soluble sulfur contents of the soil indicate the readily available sulfur supply. Reserve sulfur measures the organic or long-time supply. Increasing soil acidity generally results in greater accumulations of available sulfur in the subsoil. By use of these methods, an evaluation of the sulfur status is possible for long and short-time needs. A buildup of available sulfur at a soil depth were roots may develop is undoubtedly partly responsible for plants recovering from early symptoms later in the season.

A close relation was found between the sulfates in soils and plants. Cotton leaves and petioles taken at half-bloom from plants showing sulfur-deficiency symptoms contained an average of 130 p.p.m. of SO_4-S; whereas adequately fertilized plants contained an average of 2,273 p.p.m. of SO_4-S. Soil samples taken simultaneously with the plant samples showed an average of 3.4 p.p.m. and 106.4 p.p.m. for the sulfur-deficent and sulfur-treated plots, respectively. The difficulty of sampling the soil where the sulfur was band-placed was indicated by the soil analysis being only about 45 percent as effective as the plant analysis as a diagnostic tool.

Field response to applied sulfur by cotton and forage crops, coupled with low native supplies in soils and rainwater, shows the need to consider this essential nutrient on its own merits. Casual reliance on additions of sulfur as an incidental component of fertilizers and pesticides should be replaced by a planned program of sulfur fertilization.

Tables.

S.C. Agr. Expt. Sta., Clemson Col., Clemson, S.C.

113. Ivanoff, S. S. NEW LIGHT ON CANTALOUPE PROBLEM: MICRONUTRIENT CHLOROSIS SEEMS RELATED TO SUBSOIL LEVEL. Miss. Farm Res. 27(3): 6. 1964.

A micronutritional disease on cantaloupe vines, frequently encountered in Mississippi, was described. The vines turn yellow from the start; some die; others eventually may recover. Fertilizing such vines with commercial fertilizers containing N, P, and K did not help. The trouble was completely corrected by spraying the chlorotic vines with 0.1 percent solution of either: Zinc sulphate; sodium molybdate; or boric acid. Each of these compounds, applied alone, induced a quick recovery of the green color of the foliage and stimulated an unusually rapid growth of the vines.

In the field, some plants developed the chlorosis, while their neighbors remained healthy. This was associated with the fact that the subsoil, which probably contains all the micronutrients necessary for normal plant growth, is undulating in outline. Thus, plants growing over deep topsoil, lacking available micronutrients, fail to reach the subsoil and consequently develop the chlorosis, while those plants situated closer to the subsoil make the vital contact and develop normally. This may help to explain why this micronutrient deficiency trouble may be corrected by any of the three elements —zinc, molybdenum, or boron—and why recovering plants eventually burst forth in vigorous growth. When one needed micronutrient is applied to the foliage of a dying chlorotic plant, it acts as a stimulus, enabling the roots to reach down to the pockets and the recess of the subtaining subsoil, where the other needed micronutrients are assumed to be found, together with the accumulated N, P, and K. A very green and vigorous plant is then produced.

Miss. State U., Agr. Expt. Sta., State College, Miss.

114. Foy, C. D. TOXIC FACTORS IN ACID SOILS OF THE SOUTHEASTERN UNITED STATES AS RELATED TO THE RESPONSE OF ALFALFA TO LIME. U.S. Dept. Agr. Prod. Res. Rpt. 80, 26 pp. 1964.

Greenhouse experiments were conducted to identify toxic factors in 17 acid soils of the southeastern United States, and to relate levels of such factors to lime response of alfalfa.

Manganese toxicity was the primary limiting factor in the growth of alfalfa on acid Johnsburg (pH 5.1), Taloka complex (pH 5.2), Zanesville (pH 4.9), Loring 2 (pH 5.1), Loring 1 (pH 5.3), Dundee (pH 4.8), Calloway (pH 5.4), Cecil (pH 5.2), and Waynesboro (pH 5.2) soils. Significant yield responses to applications of lime on these nine soils were closely associated with decreases in exchangeable manganese in the soils and with decreases in toxic symptoms and manganese contents of plants. Liming these soils reduced levels of extractable aluminum, but the evidence for aluminum toxicity was weak in comparison with that for manganese toxicity.

Two other high-manganese soils, Decatur (pH 5.5) and Vaiden (pH 5.8), did not give significant yield responses with lime, and plants did not accumulate high concentrations of manganese or show symptoms of manganese toxicity.

Aluminum toxicity appeared to be the primary growth-limiting factor in acid Bladen soil (pH 4.8). Alfalfa yield responses to applications of lime on this soil were closely related to decreases in extractable aluminum in the soil. Plant symtoms on the acid soil resemble those of extreme phosphorus deficiency and were identical to those produced by excess aluminum in sand culture.

Bayboro soil (pH 4.3) contained as much extractable aluminum as Bladen, but the Bayboro soil was much less toxic to alfalfa and did not give a significant response to lime.

Calcium deficiency appears to be the first limiting factor in acid Leon soil (pH 4.2). Linear alfalfa yield increases obtained by liming Leon soil to pH 7.0 were accompanied by linear increases in the percentage of calcium in plants.

Yield-limiting factors in acid Lakeland, Tifton, and Rains soils were not conclusively identified. Results of soil and plant analyses and observations of plant symptoms suggest that calcium deficiency limited alfalfa yields to some extent on all three unlimed soils. On Lakeland and Rains soils, aluminum toxicity also appears to be involved. There was weak evidence for manganese toxicity on Lakeland and Tifton soils.

These studies were conducted with surface soils under greenhouse conditions. The results obtained are, therefore, more nearly representative of the seedling establishment stage than of subsequent periods of alfalfa growth.

Alfalfa yields tended to decrease with liming above pH 5.0 on Johnsburg and Bayboro, pH 5.5 on Waynesboro, Bladen, and Rains, pH 6.0 on Taloka complex, pH 6.3 on Lakeland, pH 7.0 on Vaiden, and pH 7.6 on Tifton. Yield decreases associated with liming were more severe on Rains and Bladen than on the other soils of this group. Chlorotic symptoms were observed, but the causes of yield depression were not determined. Overliming effects on these soils should receive further study.

SWCRD, ARS, USDA, Beltsville, Md., 20705

115. Bjornson, C. B. SOURCES OF NITRATE INTOXICATIONS IN NORTH DAKOTA. N. Dak. Farm Res. 23(3): 16-20. 1964.

Poisoning due to nitrates causes sudden death losses in some livestock when animals consume feed or water that contains toxic levels of the anion either alone or in combination. Nitrates as such are relatively nontoxic. Their importance as a cause of poisoning is due to their conversion in the foodstuff or within the alimentary tract to nitrite. Nitrites complete with oxygen, converting the hemoglobin of the blood to methemoglobin, which does not function as an oxygen carrier.

Nitrates in water supplies are not removed by filters, ordinary water softeners, nor by adding water softening compounds. However, nitrates can be removed by two tanks filled with ion exchange resins. The cost varies from about $1.00 per 1,000 gallons for water low in mineral content to $5.00 or more per 1,000 gallons in water high in mineral content. The inconvenience and expense, together with the hazard of equipment failure, indicate that reconstruction or well abandonment for replacement with a safe supply should be recommended.

If nitrate poisoning occurs on grazing land, the animals should be taken off this pasture until the problem of high nitrates corrects itself. Nitrate concentration can be analyzed at different times, and livestock losses can be avoided if animals are fed a known low nitrate ration (nearly all plants contain some nitrates) before giving them access to a suspected or high nitrate feed or pasture.

For prevention, place high energy feed with the part of rations that contains known levels of high nitrates. Molasses and ground corn have been used successfully. Four percent molasses for every 1 percent nitrate in the ration can be used. Feed a balanced ration at all times, but in the case of toxic nitrate feeds, it becomes more important to do this.

Green feed along with vitamins A, D, and E tend to reduce the toxic effect of nitrates. A stabilized vitamin A supplement, good quality alfalfa hay, or silage that has been analyzed and found nontoxic for nitrates, can be used.

If a nitrate problem is suspected, a vitamin A supplement is preferred while feed, hay, and water supplies are being tested.

Toxic forage can be made safe by mixing with other forages of known low levels of nitrates without harmful effects. The laboratory results of the feed should be used as a guide for mixing additional forages with the known toxic forage.

Consult the local veterinarian and county extension agent if high nitrates are suspected.

N. Dak. Agr. Expt. Sta., N. Dak. State U. Agr. and Appl. Sci., Fargo, N. Dak.

116. Hill, R. M., and Ackerson, C. W. NITRATE IN CATTLE FEEDS CAN BE DEADLY. Nebr. Agr. Expt. Sta. Q. 11(2): 3-5. 1964.

Nitrate is the chief form of nitrogen taken up by growing plants. Usually plants use this nitrogen rapidly for the manufacture of protein and ordinarily only small amounts of nitrate are found upon analysis. Occasionally, however, nitrate may accumulate to such an extent as to be dangerous to animals eating the plants.

Nitrate itself is not particularly toxic to animals. When it is eaten, the microorganisms in the digestive tract convert it to nitrite and finally to ammonia. Nitrite is about 10 times as toxic as nitrate. The nitrite passes into the blood stream where it reacts with the hemoglobin, the oxygen carrier of the blood, to form methemoglobin which is incapable of carrying oxygen. When enough hemoglobin is thus converted, the animal dies of asphyxiation.

There has been an increasing interest in the nitrate content of cattle feeds in the last decade. During this period, the nitrate in an ever-increasing number of samples were measured to determine the extent of nitrate accumulation in Nebraska feeds. The Nebraska feedstuffs frequently contained moderate and occasionally lethal levels of nitrate.

Research is being conducted to find the best time and method of harvest which will enable the farmer to produce feedstuffs low in nitrate. Various methods of silage storage as well as different ensiling agents will be studied to determine conditions which will best insure the elimination of any nitrate which might be present in the plant material.

Accurate diagnosis of nitrate poisoning is difficult. Clinical symptoms such as abortion, weakness of the new born, infertility, lameness, stiffness, unthriftiness, trembling, and loss of milk production are vague and non specific symptoms and can all be caused by conditions other than nitrate.

One of the best single diagnostic tools is the color of the blood.

If cases of nitrate poisoning can be recognized before they become too far advanced, they can be treated with intervenous injections of methylene blue plus additional vitamin A. The most frequently recommended dose is 4 milligrams of the dye per pound of body weight administered as a 4 percent solution. Any treatment must include elimination of the nitrate containing feeds from the ration.

While relatively few sampes analyzed contained lethal levels of nitrate, feedstuffs frequently contained sufficient nitrate to cause concern, especially when they were the sole constituent of an animal ration.

While high nitrate may be found under good growing conditions, drought increases the probability that excess nitrate may occur.

In 1962, 97 percent of some 1,200 irrigation wells in Nebraska showed less than 10 p.p.m. nitrate nitrogen and only 30 of the wells contained more than 10 p.p.m. The highest level in any of these wells was 24.8 p.p.m. nitrate nitrogen.

The 1961 drinking water standards allow 10 p.p.m. nitrate nitrogen in drinking water, even for infants. Thus, from the standpoint of nitrate content, most Nebraska ground water would be considered safe.

U. Nebr. Col. Agr., Agr. Expt. Sta., Lincoln, Nebr.

117. Takijima, Y. STUDIES ON THE MECHANISM OF ROOT DAMAGE OF RICE PLANTS IN THE PEAT PADDY FIELDS, I. ROOT DAMAGE AND GROWTH INHIBITORY SUBSTANCES FOUND IN THE PEATY AND PEAT SOIL. Soil Sci. and Plant Nutr. 10(6): 231-238. 1964.

Rice plants grown in the peat paddy field suffer from nutritive disturbance throughout the whole growth stage when under ill-drained field conditions. The roots lose the activity of absorbing nutrients even at the stage of slight iron deposition to the root surface, finally being intruded with excess ferrous iron and sulfide. Poor root growth as found in the field was easily reproduced when rice seedings were cultured in the peaty and peat soil leachate.

Results of the root growth experiments using the leachates subjected to various treatements showed the presence of many harmful unknown substances having reducing, volatile, and weak acidic properties and substances stable to oxication. Among them aliphatic carboxylic acids were sometimes sufficient to be inhibitory to the root growth. The other unknown substances, probably derived from humus subordinates and present in small amounts respectively, might be playing a role in the root damage occurrence as well as the major soil metabolities such as ferrous iron, sulfide, and aliphatic acids.

Natl. Inst. Agr. Sci., Nishigahara, Tokyo, Japan.

118. Ohman, J. H., and Kommedahl, T. PLANT EXTRACTS, RESIDUES, AND SOIL MINERALS IN RELATION TO COMPETITION OF QUACKGRASS WITH OATS AND ALFALFA. Weeds 12(3): 222-231. 1964.

When crop plants were competing with well-established quackgrass (Agropyron repens) for the same nutrient supply, chlorosis and stunting of crop plants occurred. Apparently this was due to the greater ability of quackgrass to withdraw available nutrients, especially nitrogen, and to a lesser extent phosphorus and potassium, from the nutrient solution.

No evidence was obtained for a phytotoxic substance from living quackgrass roots or rhizomes that could inhibit germination or growth of alfalfa and oats. Quackgrass residues in large amounts caused chlorosis and stunting in alfalfa and oats when added to soil. The evidence obtained linked this behavior to the high C:N ratio with consequent temporary deficiency of available nitrogen. Water extracts of quackgrass leaves or rhizomes were not phytotoxic unless subjected to high temperatures during or subsequent to extraction. If soils contained decomposing quackgrass or crop plant residues, extremely phytotoxic extracts of such soils were obtained, but only when soils were saturated and decomposition was anaerobic.

Lakes States Forest Expt. Sta., FS, USDA, Marquette, Mich.

119. Binns, W., James, L. F., Shupe, J. L., and Everett, G. A CONGENITAL CYCLOPIAN-TYPE MALFORMATION IN LAMBS INDUCED BY MATERNAL INGESTION OF A RANGE PLANT. Amer. J. Vet. Res. 24(103): 1164-1175. 1963.

A congenital cyclopian-type malformation in lambs, which has occurred in epidemic proportions in certain bands of range sheep, was reproduced under controlled experimental conditions by feeding Veratrum californicum in both the fresh green and green dried forms. The V. californicum plant was shown to vary widely in toxicity and teratogenic agent content between the different range areas.

Individual sheep feeding experiments with V. californicum and range grazing experiments on ranges heavily infested with the plants demonstrated the following: (1) When the ewes ingested the plants from the 1st to the 10th day of the gestation period, the fetus was not affected; (2) ingestion of the plant from the 1st to the 15th day of gestation caused cyclopian-type deformities to occur in the lambs; and (3) when ingestion of the veratrum plant was continued after the 15th day, an abnormally high number of ewes tended to recycle.

All fetuses obtained from these ewes prior to their recycling had undergone fetal death and were severely malformed.

The range lands were the cylopian-type deformity occurs, the incidence of dry ewes at lambing time may vary from 10 to 15 percent rather than the normally expected 1 percent.

AD and PRD, ARS, USDA, Logan, Utah.

120. Shupe, J. L. (Author) and Cox, L. M. (Ed.) FLUOROSIS IN LIVESTOCK. Utah Sci. 25(2): 44-45, 57-58. 1964.

Animals normally ingest variable levels of fluorine throughout their lives. So long as they continue to ingest a constant or increasing amount, some of the flourine accumulates in their bodies. If amounts of fluorine above the threshold or critical level are ingested over long periods of time, fluorine toxicosis may result. This toxicosis may be either acute or chronic, but the chronic form is more common in livestock.

Chronic fluorosis develops gradually, and every affected animal will evidence an individualized manifestation of the typical lesions. It is impossible, therefore, to define a precise point at which an instance of normal consumption will become a case of chronic fluorosis. The borderline or threshold point will vary somewhat in individual cases as the seven following interacting factors exert their influence: (1) Level or amount of fluoride ingested; (2) duration of ingestion—time; (3) type and solubility of fluoride ingested; (4) age of animal during period of ingestion; (5) level of nutrition; (6) stress factors; and (7) individual biological response.

The inevitable time lapse between ingestion of elevated levels of fluorides and actual manifestation of the clinical symptoms of chronic fluorosis adds to the complexity of the clinical picture.

Actual instances of fluorosis in livestock may be traced to any of a variety of sources that may act singly or in combination. The most commonly encountered sources include: (1) Forages having elevated concentrations of fluorine compounds as a result of airborne contamination in area near industrial plants that heat fluorine-containing materials to high temperatures and expel fluorides; (2) vegetation having a high fluoride content because it grew on soils of high fluoride content; (3) feed concentrates and mineral mixtures high in fluoride; and (4) drinking water high in fluoride.

Under field conditions, the amounts of fluoride ingested and the lengths of time during which it is ingested are subject to wide variations. There may be intermittent periods during which no excessive fluorides are ingested. Different levels of nutrition and different management practices can affect manifestations of fluorotic lesions. The usual variability between individual animals within and between herds can also modify manifestations of the disease. Whether an animal consumes elevated levels of fluorine throughout its life, or only after its teeth are formed, will determine whether fluorotic dental lesions occur.

About 95 percent of the total fluoride retained in the animal body is found in the bone, and in the enamel, cementum, and dentine of the teeth. This retention pattern has made possible the establishment of certain criteria that are useful in evaluating the degree of fluorosis.

Agr. Expt. Sta., Utah State U., Logan, Utah.

121. Reith, J. W. S., Inkson, R. H. E., Holmes, W., Maclusky, D. S., Reid, D., Heddle, R. G., and Copeman, G. J. F. THE EFFECTS OF FERTILIZERS ON HERBAGE PRODUCTION: II. THE EFFECT OF NITROGEN, PHOSPHORUS AND POTASSIUM ON BOTANICAL AND CHEMICAL COMPOSITION. J. Agr. Sci. 63(2): 209-219. 1964.

Six factorial experiments, each lasting 3 years were carried out to determine the effects of N, P, and K on herbage cut five times each year.

Clover almost disappeared with the 87 lb. N treatment and none survived with the 174 and 348 lb. dressings. N increased the proportions of rye-grass and cocksfoot in the sward. P had no influence on botanical composition. K usually increased the clover content in the absence of N but had practically no effect in the presence of N.

The crude-protein content was higher in autumn than in summer. The percentage with both the 87 and 174 lb. N treatments was usually lower than with no N, but was increased by 348 lb. N. Where K produced higher yields, the percentage ususally showed a negative interaction between the N and K dressings. With adequate K, 348 lb. N per annum at least doubled the production of crude protein. At this rate, the apparent recovery of applied N was generally between 40 and 50 percent.

The P percentage of the herbage showed no large seasonal variations and was generally increased by the superphosphate dressings. The uptake was practically doubled by the 348 lb. N treatment but the apparent recovery of applied P was only between 4.4 and 7.8 percent. On arable land previously treated with substantial dressings of P, established grass can extract considerable quantities of soil P and only occasionaly maintenance dressings need to be applied.

The K content of the herbage was generally much lower in the absence than in the presence of applied K at all N levels. Applying K for each cut produced a small seasonal increase in the percentage but there was no increase when it was applied in early spring. The uptake figures give apparent recovery of K between 11 and 100 percent depending on the response.

The percentage of Na showed a seasonal increase. Applying K markedly reduced Na but N increased it.

There were clear seasonal increases in the percentages of both Ca and Mg in the herbage. Applying N and K separately had a variable effect on the Ca percentage but when both were applied together, the percentage was usually reduced. The N treatments tended to increase rather than decrease the Mg content but K generally depressed the percentage. This effect of K on the Mg percentage was appreciably less in the presence than in the absence of N and also tended to be smaller when the dressing was applied for each cut than in one application in spring.

The influence of selected treatments on a range of trace elements was measured at one center. The 348 lb. N treatment reduced the Co, Mn, and Sr contents but there were no other large effects of the treatments.

At moderately high N rates, applying 1 lb. K_2O for every lb. N was more than adequate to maintain potash supplies and a slightly lower rate of about 0.75 lb. K_2) seemed to be sufficient on most of the soils represented.

Grass treated with heavy dressings of N and regularly cut for conservation removes larger quantities of nutrients from the soil than arable crops and it is essential to replenish them.

Macanlay Inst. Soil Res., Aberdeen, Scotland.

122. Carter, L. P., and Scholl, J. M. EFFECTIVENESS OF INORGANIC NITROGEN AS A REPLACEMENT FOR LEGUMES GROWN IN ASSOCIATION WITH FORAGE GRASSES. II: NITROGEN CONTENT, YIELD OF NITROGEN, AND SEASONAL DISTRIBUTION. Agron. J. 56(3): 287-290. 1964.

A study to evaluate the effect of nitrogen, supplied by ammonium nitrate, on the nitrogen yield and nitrogen content of orchardgrass and bromegrass in pure stand and in association with alfalfa and red clover, was conducted at Ames, Iowa, during 1957-59. The grasses were grown with 0, 30, 60, 120, or 240 pounds of elemental nitrogen applied annually and in association with alfalfa or red clover without and with 60 pounds of N in 1958 and 1959. The seasonal production of nitrogen and seasonal changes in percent nitrogen were determined each year for the grasses grown alone and for each component of the mixtures.

The yields of N in the pure grass stands were increased with each additional increment of fertilizer nitrogen. Most of the difference in total nitrogen yield of the grasses was accounted for in the first and second harvests. The nitrogen yields in 1959 were not as high as in 1958.

When a split application of 120 pounds of N was applied and compared with a single 120-pound application, there was no significant difference in the total nitrogen yields for the season. More nitrogen was recovered in the forage from that applied in 1958 than in 1959. Higher recovery was noted for orchardgrass than for bromegrass. There was no significant carryover of nitrogen from 1958 to 1959.

The percent nitrogen in the grasses grown alone increased with each increase in nitrogen fertilizer applied. This difference came primarily in the first harvest, and each successive harvest showed less difference among the treatments until, in the fourth harvest, there was little difference among treatments. The effect of water availability on nitrogen yield with increasing rates of nitrogen fertilization was well demonstrated.

The application of fertilizer N to four grass-legume mixtures resulted in increased nitrogen yield. This resulted primarily from an increase in the grass component. The nitrogen yield of the unfertilized mixtures appeared to be comparable to the nitrogen yield of the grasses grown alone with 240 pounds of fertilizer nitrogen.

The percent N in the bromegrass component of bromegrass-legume mixtures appeared to be higher than that of orchardgrass in similar mixtures. The legume component was consistently greater in mixture with bromegrass than with orchardgrass. Fertilization of the mixtures resulted in an increase in N in the grass component in the first harvest. In subsequent harvests, there was little difference resulting when fertilizer was added.

Mont. State Col., Bozeman, Mont.

123. Sorteberg, A., and Dev, G. EFFECT OF LIMING PEAT SOILS ON THE AVAILABILITY OF APPLIED PHOSPHATE TO PLANTS. Agr. Scandinavia 14(4): 307-314. 1964.

It was postulated that liming of peat soils may fail to improve the direct availability of applied phosphate to plants. To test this, a greenhouse pot experiment was carried out for two consecutive years with three peat soils, using oats as test crop.

In these experiments, three doses of lime—1.5, 4.5, and 9.0 tons of CaO per hectare (2.41 acres) were combined with four doses of superphosphate—20, 60, 180, and 540 kg. (2.2046 lb.) of P per hectare.

Significant effects of interaction between phosphorus and lime in respect of yield were found, particularly in the first year, so that the maximum yield at a lower liming was combined with a relatively low rate of phosphorus, while the maximum yield at a high rate of lime was combined with a higher rate of phosphorus.

The relative P content of plants decreased both years with increasing rates of lime. It was suggested that the depression in percentage of P in plants caused by liming was due to a higher grade of reversion of soluble phosphate. Increasing applications of phosphorus gave an increased content of phosphorus in plants. A maximum content of P in plants was found at a minimum rate of lime in combination with the highest dose of phosphorus.

During the second-year growth, the content of P in plants and the total removal of P by plants were higher than during the first-year growth, owing to the residual effect of the first year in addition to the effect of the phosphorus supplied the second year.

Agr. Col. Norway, Vollebekk, Norway.

124. Anderson, J. F., Bailey, J. S., Drake, M., Olanyk, G. W., and Field, D. L. MINERAL CONENT OF STRAWBERRY LEAVES AS INFLUENCED BY RATE AND PLACEMENT OF FERTILIZER AND LIME. Proc. Amer. Soc. Hort. Sci. 85: 332-337. 1964.

In 1961, leaf P was increased in strawberries by increments of applied fertilizer N as well as fertilizer P, indicating an N-P interaction. New leaves were higher than old in P and K, but were lower in Ca and Mg. The new leaves were more sensitive than old in reflecting the P fertilizer treatments. Applications of lime tended to suppress root growth.

In 1962, percentage leaf P was increased by increments of applied P and by concentrating the P fertilizer in bands below the roots. Applying P to the daughter plants as compared to applications to the mother plant increased the leaf P from 0.114 to 0.251 percent indicating the importance of abundant available soil phosphorus for developing daughter plants.

Rates of lime had no effect on percent Ca in the leaf in September, but by December there were large increases in leaf Ca produced by increments of lime.

Comparing large and small nursery plants with a 2:1 dry weight ratio, the large plants contained more than double the amount of P, K, Ca, and Mg.

U. Mass., Amherst, Mass.

125. Somogyi, L. P., Childers, N. F., and Eck, P. INFLUENCE OF NITROGEN SOURCE AND SOIL ORGANIC MATTER ON THE CRANBERRY (VACCINIUM ACROCARPON AIT.) Proc. Amer. Soc. Hort. Sci. 84: 280-288. 1964.

A greenhouse study was made of the effect of slowly and readily available forms of N on growth and N content of the cranberry grown in substrates of different organic matter content. The treatments consisted of the following N sources: (1) Urea-formaldehyde (UF); (2) urea; (3) $(NH_4)_2SO_4$; (4) a mixture of urea-formahldehyde and urea with 50 percent of the N from each source (UF-urea). Each fertilizer treatment was applied to three substrates at a rate of 50 lb. N/A. at the beginning of the first and third growing seasons. The different substrates contained three levels of organic matter: (1) High (a cranberry bogsoil containing 4 percent organic matter); (2) none (coarse sand); and (3) medium (50-50 mix of (1) and (2)).

Urea and urea-formaldehyde were most effective in promoting cranberry growth when applied to a substrate containing organic matter. Ammonium sulfate produced vigorous growth on all substrates including pure sand. The mixture of urea and UF produced more uprights, runner growth, and total dry matter than either urea or UF separately, indicating the added effectiveness of a sustained N supply over the growing period.

At the end of the second growing season, the development of a red coloration in the leaves was associated with low N content (0.8 percent) in the leaf. The N deficiency was most prevalent on the treatment receiving $(NH_4)_2SO_4$. Treatments receiving the organic sources of N had consistently higher N contents in the plant tissues.

Rutgers—The State U., New Brunswick, N.J.

126. Mason, J. L. YIELD AND QUALITY OF APPLES GROWN UNDER FOUR NITROGEN LEVELS IN UNCULTIVATED GRASS SOD. Proc. Amer. Soc. Hort. Sci. 85: 42-47. 1964.

Apple trees growing in uncultivated grass sod mown monthly were fertilized with 1/2, 1, 2, or 4 pounds of N as ammonium nitrate each fall for 6 years. Red skin color of fruits was reduced by 9 percent at the higher N rates and maturity of trees in the fall was delayed. Leaf-N content was increased from 2.12 to 2.34 percent. There was no effect of the N treatments on total yield of fruit, length of terminals, fruit flavor, size, titratable acidity, conductivity, or soluble solids content. It was concluded that uncultivated grass sod can largely eliminate the usual tree responses from heavy applications of N fertilizer except for fruit color leaf-N content and fall tree maturity.

Canada Dept. Agr., Summerland, British Columbia, Canada.

127. Uriu, K., and Koch, E. C. RESPONSE OF YELLOW NEWTOWN APPLE LEAVES TO FOLIAR APPLICATIONS OF MANGANESE AND ZINC. Proc. Amer. Soc. Hort. Sci. 84: 25-31. 1964.

An interveinal chlorosis of Yellow Newtown apples was found to involve two nutrient deficiences. A Zn spray alone gave no correction; Mn alone corrected the interveinal chlorosis but left a mottled pattern suggestive of a mild Zn deficiency; a combination Zn plus Mn spray completely corrected the chlorosis.

The chlorotic symptoms and the low Mn levels in the leaves indicated severe Mn deficiency while the Zn levels indicated a mild Zn deficiency. The Mn deficiency masked the Zn deficiency and only after the former was corrected did a Zn symptom appear.

Early spring sprays of Mn plus Zn applied at least two times corrected the symptoms for the entire year. The symptoms reappeared the following year. Leaf analysis and visual observations showed practically no carryover effect of the sprays.

U. Calif., Davis, Calif.

128. Stiles, W. C. INFLUENCE OF CALCIUM AND BORON TREE SPRAYS ON YORK SPOT AND BITTER PIT OF YORK IMPERIAL APPLIES. Proc. Amer. Soc. Hort. Sci. 84: 39-43. 1964.

York Imperial apple trees in two commerical orchards in southern New Jersey were sprayed at various times during the 1960-62 growing seasons with calcium, boron, and other chemicals. Fruits from these trees were evaluated for susceptibility to York spot and bitter pit and for fruit size.

Reductions in percent of fruit affected with York spot obtained through the use of $CaCl_2$ sprays were associated with reductions in size of fruit at harvest. Average numbers of York spots per fruit were descreased by $CaCl_2$ and boron tree sprays in the absence of a significant reduction in final fruit size.

The severity of bitter pit was reduced by summer sprays of $CaCl_2$ regardless of the influence of the sprays on average fruit size.

Rutgers—The State U., New Brunswick, N.J.

129. Somogyi, L. P., Childers, N. F., and Chang, S. S. VOLATILE CONSTITUENTS OF APPLE FRUITS AS INFLUENCED BY FERTILIZER TREATMENTS. Proc. Amer. Soc. Hort. Sci. 84: 51-58. 1964.

Samples of five apple varieties harvested from trees under various fertilizer treatments in New Jersey, Maine, Canada, and Denmark were studied with respect to the composition of their volatile components by use of gas-liquid chromatography.

McIntosh from the high-N treatment from Maine showed an increase in volatile content over the low-N treatment. For the Canadian samples, the applications of 1.5 lb. N as NH_4NO_3 increased the volatile content of fruits over the 1.0 lb. N treatment, while 2.0 lb. of N was the same as the 1.5 lb. treatment. In the 12-5-7 treatments, volatile content of the apples increased with increased fertilizer application up to 2 lb. N per tree (the 2.5 lb. N treatment resulted in little change in volatile content).

Nitrogen applied alone resulted in the lowest total volatile content in fruits of Delicious, Rome Beauty, and Stayman apples in New Jersey as compared with NK, NPK, NPK+TE (trace elements), and 2N+PK+TE treatments.

In Cox's Orange Pippin, volatile content of samples was higher following soil applications of $Ca(NO_3)_2$ than in the no-N treatment. Calcium nitrate treatments supplemented with 9 to 12 foliar sprays of 1 percent urea and 1 percent $MgSO_4 \cdot 7H_2O$ gave a further increase in the total volatile content of the applies.

Gas-liquid chromatographic equipment provided a valuable quantitative and qualitative method of analyzing the volatile flavor components of apple fruits. The results presented indicated that the volatile flavor content of apples as well as the relative amounts of the different components may be influenced by nutrition. It remains to be determined, however, if total volatiles or specific volatiles, determined by GLC, were correlated with fruit quality.

Rutgers—The State U., New Brunswick, N.J.

130. Mason, J. L. EFFECT OF EXCHANGEABLE MAGNESIUM, POTASSIUM AND CALCIUM IN THE SOIL ON MAGNESIUM CONTENT OF APPLE SEEDLINGS. Proc. Amer. Soc. Hort. Sci. 84: 32-38. 1964.

A gravelly sandy loam soil from a semi-arid region of British Columbia in western Canada was leached with H ions and reconstituted with added Ca, Mg, and K in various ratios. Seedlings of McIntosh apple were grown in the modified soil and harvested when 9 inches high. When the Ca:Mg ratio was varied from 16:1 to 1:1, the Mg content of the leaves was increased from 40 to 77 meq./100 g., the Ca was reduced from 51 to 37 meq./100 g., and the K was also reduced from 56 to 47 meq./100 g. When the Mg:K ratio was varied from 27:1 to 1:3, the Mg content of leaves was reduced from 66 to 40 meq./100 g., the Ca content was reduced from 48 to 39 meq./100 g., and the K was increased from 47 to 72 meq./100 g. There was only a slight effect of the treatments on yield. There was a slight decrease in N content of leaves as Mg content increased.

Canada Dept. Agr., Summerland, British Columbia, Canada.

131. Labanauskas, C. K., and Puffer, R. E. EFFECTS OF FOLIAR APPLICATIONS OF MANGANESE, ZINC, AND UREA ON VALENCIA ORANGE YIELD AND FOLIAGE COMPOSITION. Proc. Amer. Soc. Hort. Sci. 84: 158-164. 1964.

Main effects and interactions of foliar sprays of Mn, Zn, and urea in factorial combinations were studied, relative to: (1) Yield of Velancia oranges; (2) dry weight of leaves; (3) micronutrient and nitrogen concentrations in unsprayed and sprayed leaves; (4) correction of deficiency symptoms; and (5) duration of response in cases of mild Mn and Zn deficiencies.

As compared with appropriate control treatments, foliar applications of Mn to Mn-deficient orange trees increased yield of oranges, dry weight of leaves, and Mn concentration in the sprayed leaves. Small, but detectable amounts of Mn were translocated from the sprayed leaves into the new flush of the following spring.

Zinc foliar sprays on moderately Zn-deficient orange trees markedly increased Zn concentration in the sprayed leaves, as compared with appropriate control treatments. Also, small amounts of Zn were translocated from the sprayed symtom-free leaves into the new flush of the following spring. Urea foliar applications increased N and Mn concentrations in the sprayed leaves, as compared with appropriate control treatments. Applications of Zn did not affect yields of fruit.

Foliar applications once a year of Mn and Zn, alone, or in mixtures, corrected Mn and Zn deficiency symptoms and markedly increased Mn and Zn concentrations in sprayed leaves, but failed to prevent symptoms from developing on the subsequent new flush.

This study suggested that analysis of Mn and Zn sprayed leaves, when properly cleaned, leads to a better understanding of resultant effects than analysis of leaves from growth cycles that occur after trees are sprayed.

U. Calif. Citrus Res. Cent., Agr. Expt. Sta., Riverside, Calif.

132. Clor, M. A., Crafts, A. S., and Yamaguchi, S. TRANSLOCATION OF C^{14}-LABELED COMPOUNDS IN COTTON AND OAKS. Weeds 12(3): 194-205. 1964.

Direction and rate of translocation of sucrose from 2,4-D, and amitrole were toward regions of active growth. In oak seedlings, translocation was slower than in cotton seedlings. In oak seedlings, growing leaves and shoots constituted active sinks toward which tracers moved. Sucrose from urea translocated freely; 2,4-D moved less freely because of accumulation enroute; amitrole was intermediate between these. High humidity induced rapid and extensive uptake of tracers by oak seedlings; the increase over normal transport was mainly in the xylem.

Jr. Author, U. Calif., Davis, Calif.

133. Hoyle, M. C., and Mader, D. L. RELATIONSHIPS OF FOLIAR NUTRIENTS TO GROWTH OF RED PINE IN WESTERN MASSACHUSETTS. Forest Sci. 10(3): 337-347. 1964.

The use of foliar analysis for identification of limiting nutrients in a forest site study in *Pinus resinosa* Ait. plantations was investigated. Application of multiple regression analysis to foliar nutrient data from a series of stands was tested and appeared feasible for isolating independent relations of nutrients with growth. The results of different modes of nutrient expression were compared. The results suggest that some measure of total uptake may be superior to percentages. Various growth measures exhibited different relationships to foliar nutrient level, calcium was strongly related to height growth, potassium to basal area growth, while volume growth was related significantly to soil moisture capacity.

Need for further study of the interrelationships between various phases of growth and the factors controlling them was indicated. Some possible causes for the different relationships were postulated, such as seasonal changes in nutrient availability. High correlation between foliage calcium contents and height growth had not previously been reported in studies concerning nutrient deficiencies of red pine.

Northeastern Forest Expt. Sta., FS, USDA, Laconia, N.H.

134. Wilcox, G. E. EFFECT OF POTASSIUM ON TOMATO GROWTH AND PRODUCTION. Proc. Amer. Soc. Hort. Sci. 85: 484-489. 1964.

Potassium applications to soils that contained 100 and 150 lb./A. exchangeable K increased tomato yields about 30 percent. Among the plant growth responses to increased K were longer internodes, larger stems, lighter green young terminal leaves (an effect due to growth rate), and reduced fruit dropping during ripening on the vine. Leaf K composition of 2.3 percent or above at time of heavy fruit load was required for optimum yields. Pedicel development of the K deficient plants showed a wide band of small cells in the abscission zone, and separation (fruit dropping) occurred when fruit approached the ripe stage.

Purdue U., Agr. Expt. Sta., Lafayette, Ind.

135. Haddock, J. L., and Stuart, D. M. THE INFLUENCE OF FACTORS OTHER THAN SOLUBLE PHOSPHORUS IN THE NUTRIENT MEDIUM ON THE PHOSPHORUS CONTENT OF SUGAR BEET PLANTS. Amer. Soc. Sugar Beet Tech. 12(8): 641-650. Jan. 1964.

The nutrient concentration and balance most suitable for the growth of sugar beet plants was determined. Sugar beet plants growing in nutrient cultures similar in phosphorus concentration, produced plant tissue varying widely in phosphorus composition.

Data were given to show the extent of these variations and to attempt an explanation as to some of the probable causes for variation in phosphorus content of plant tissue. The author concluded that:

1. Many factors influence phosphorus uptake by sugar beet plants. No single theory of phosphorus availability accounted for all conditions of phosphorus absorption.
2. The mechanisms of nutrient absorption of anions and cations may well differ as Lundegardh (1951) contends. Nevertheless as interdependence seems to exist among them for absorption by plant roots. There was an indication that the ammonium ion and the monovalent phosphate ion were congenial plant absorption companions.
3. At a given pH value of nutrient solution in the rooting medium, the rate of phosphorus absorption by sugar beets depended upon the quantity of soluble phosphorus present, as stated by Pratt and Thorne (1948). The pH of the nutrient medium appearred to be one of the important factors controlling the rate of phosphorus absorption, frequently over-riding the influence of solution concentration, McGeorge (1932).
4. High concentration of nitrates in the solution medium tended to repress the uptake of phosphorus and low concentration was conducive to high phosphorus absorption by sugar beets.

SWCRD, ARS, USDA, Logan, Utah, 84321

136. Hutchinson, F. E., Murphy, H. J., and Lewis, D. T. THE EFFECT OF LIMING ON YIELD, QUALITY AND CHEMICAL COMPOSITION OF CROPS IN DAIRY AND POTATO ROTATIONS FOR SEVEN YEARS ON PLAISTED SOILS IN MAINE. Maine Agr. Expt. Sta. B. 617, 38 pp. 1964.

A long term experiment was designed to evaluate the amount of lime required to attain pH levels of 5.5, 6.0, and 6.5 and the effect of these levels on the yield of crops in potato and dairy rotations. The study was conducted on a Plaisted gravelly sandy loam with an initial pH of 4.8.

For the potato rotation, limestone rates of 6,000, 11,425, and 22,010 lb./A. were applied over a period of 5 years to achieve the designated pH levels.

Over a 7 year period, potato yields first increased and then decreased with pH level as a result of successive fertilizations and liming. The average yields for the total period were 205, 206, and 188 hundredweight per acre with increasing lime level. Specific gravity values of tubers tended to increase at the higher pH levels.

Yield of oats grown following potatoes without additional fertilization were not consistently related to lime level, although a significant yield reduction was found in the last season for the pH 6.5 plots in comparison to those at pH 5.5. Average yields of 66, 68, 64 bu./A. resulted as pH value increased.

The amount of dry matter produced by a timothy and red clover forage mixture for each of 6 years exhibited a consistent increase with increasing lime level. For the last 2 years of the experiment, however, the yield at the lowest pH level was equal to those for the higher pH levels following the attainment of the desired pH values. The only significant response to lime occurred early in the study (1957) at a time when very little lime had been applied to the low lime plots.

The limestone rates applied to attain the desired pH levels for the dairy rotation were higher than those for the potato rotation because of a different series of crops and the total length of time during which liming was pursued. Total amounts of 5,935, 14,017, and 32,406 lb./A. were required to reach pH levels of 5.5, 6.0, and 6.5., respectively.

Both ear and dry matter yields of sweet corn varied directly with increasing lime level, with average yields of 7,689, 8,556, and 8,967 lb./A. of marketable ears recorded. Dry matter yields from the same plots averaged 3,723, 3,896, and 4,284 lb./A.

Although average yields of canning peas increased with lime level, the yields were not significantly different for any of the four seasons.

Over a 3 year period, the yields of snap beans were not consistent with respect to lime level but these were grown during the last part of the experiment after the desired pH values had been reached.

Alfalfa exhibited a significant growth response to lime level 3 years out of 6 in the first harvest year crop, with dry matter yields of 4,818, 6,199, and 6,705 lb./A. at pH levels of 5.5, 6.0, and 6.5, respectively. Alfalfa yields from the second harvest year plots were similar to those from the first year plots. Average yields progressed from 5,659 to 6,760 to 7,172 lb./A. with increasing lime level.

Exchangeable aluminum in the soil was established as a buffer system by the level of 219 lb./A. measured for the original site of the experiment. Evaluations made in the laboratory were accurate for predicting lime requirement to achieve pH 6.0, but the method did not predict an adequate amount to achieve pH 6.5.

Maine Agr. Expt. Sta., U. Maine, Orono, Maine.

137. Tyler, K. B., and Lorenz, O. A. NUTRIENT ABSORPTION AND GROWTH OF FOUR MUSKMELON VARIETIES. Proc. Amer. Soc. Hort. Sci. 84: 364-371. 1964.

Nutrient uptake and growth rates of PMR450 cantaloupe, Crenshwa, Honeydew, and Persian muskmelons were studied. One-half of the total dry weight was produced in the last 18 to 20 days of the 107-day growth period. Persians produced twice the dry weight of cantaloupes and appreciably more than either Honeydews or Crenshaws.

Before blossoming time, the dry matter percentage was low in the foliage of all varieties (7-9 percent) while in mature plants it averaged about 14 percent. Fruits of the four types at maturity averaged about 8 percent dry weight, and roots about 14 percent. Fresh weight of mature foliage was roughly half the weight of fruit, at the final sampling. Cantaloupes produced 16-1/2 tons of fresh foliage and fruit; Crenshaws, 21 tons; Honeydews, 22-3/4 tons; and Persians 33-3/4 tons.

Foliar concentrations of N, P, K, Ca, and Mg were fairly similar for the four types of muskmelons. Nitrogen was initially about 4-1/2 percent but decreased to about 2-1/2 percent at last sampling. Phosphorus averaged about 0.6 percent early and 0.3 percent late. Potassium in foliage at first sampling ranged from 2.8 percent in Honeydews to 3.8 percent in Persians. At final sampling, the Honeydews contained 1.4 percent K and Persians 2.6 percent. Calcium did not change greatly in concentration in foliage during the season. Foliar concentration of Mg generally increased slightly from an average of 0.7 percent to 1.0 percent.

During growth, N in fruit decreased from 3.7 percent in Honeydews and 2.7 percent in Persians to 1.4 percent and 2.0 percent, respectively. Phosphorus decreased from an average of 0.5 percent at first sampling to 0.3 percent at the final sampling. In the fruit, K decreased from an average initial concentration of 3.3 percent to 2.4 percent. Calcium dropped from an average of 0.5 percent to 0.4 percent and Mg from 0.4 percent to 0.3 percent. Nutrient concentration trends in fruit more than in foliage.

Nutrient absorption corresponded well with dry-matter production. Nitrogen and K absorption was about four times greater than P and Ca, and more than double that of Mg. Both dry-matter production and nutrient absorption were most rapid in the period from a few days after blossoming to harvest time. Persians, the heaviest feeders, absorbed a total of 135 lb./A. of N as compared to 20, 158, 27, and 38 for P, K, Ca, and Mg, respectively.

U. Calif., Riverside, Calif.

138. Dickinson, D. V., and McCollum, J. P. THE EFFECT OF CALCIUM ON CRACKING IN TOMATO FRUITS. Proc. Amer. Soc. Hort. Sci. 84: 485-490. 1964.

Cracks were induced in detached tomato fruits by infiltration with water. Adding $CaCl_2$ to the infiltrating solution prevented cracking in a crack-resistant variety (Kc146) and reduced the severity of cracking in a susceptible variety (Garden State). This protective effect of Ca may have been due to its divalent nature since monovalent cations were not effective.

Calcium chloride also reduced cracking in fruits of Garden State when applied as a spray to intact plants. Thus, application of Ca spray may become a useful method to decrease losses due to cracking.

U. Ill., Urbana, Ill.

139. Larsen, S. THE EFFECT OF PHOSPHATE APPLICATION ON MANGANESE CONTENT OF PLANTS GROWN ON NEUTRAL AND ALKALINE SOILS. Plant and Soil 21(1): 37-42. Aug. 1964.

In four field experiments, high rates of granular triple superphosphate and repeated sprays of manganese sulphate were applied to oats and sugar beet on land known to produce manganese-deficiency symptoms in these crops. Spraying did not increase the manganese content of the foliage while application of superphosphate did.

Possible explanations for this were discussed and it was suggested that the most likely one was chemical mobilization of soil manganese brought about by the reactions that the monocalcium phosphate in superphosphate undergoes in soil.

Levington Res. Sta., Ipswick, Suffolk, England.

140. Bains, S. S., and Fireman, M. EFFECT OF EXCHANGEABLE SOLDIUM PERCENTAGE ON THE GROWTH AND ADSORPTION OF ESSENTIAL NUTRIENTS AND SODIUM BY FIVE CROP PLANTS. Agron. J. 56(4): 432-435. 1964.

A greenhouse experiment was conducted to: (1) Select a test-crop plant sensitive to exchangeable sodium (alkali) and responsive to the application of fertilizers; and (2) study the effect of exchangeable sodium on the absorption of the essential nutrient elements from a non-calcarious soil. The authors concluded that:

1. Of the five crop plants (corn, sorghum, safflower, ryegrass, and tomato) tested, sorghum and ryegrass appeared to be best for studying soil fertility and alkali interrelationships. Sorghum appeared to be better than ryegrass because it was quicker to germinate and had a greater rate of growth. Corn was the least sensitive of the test crops to an ESP of 28.5 percent.
2. Exchangeable sodium caused a several-fold increase in the absorption of sodium, and a decrease in the absorption of calcium and potassium. Total and nitrate-nitrogen was increased, and phosphorus and sulfate-sulfur were decreased in most of the test crops by exchangeable sodium.
3. In most cases, exchangeable sodium caused a reduction in the absorption of the micronutrients: manganese, copper, zinc, boron, and chlorine; and an increase in the absorption of molybdenum. The exceptions were increased absorption of manganese by sorghum and ryegrass, and iron and copper by tomato.
4. Safflower was stimulated in the early stages of growth by an exchanageable sodium percentage of 28.5.

Indian Agr. Res. Inst., New Delhi, India.

141. Williams, M. W., Batjer, L. P., and Martin, G. C. EFFECTS OF N-DIMETHYL AMINO SUCCINAMIC ACID (B-NINE) ON APPLE QUALITY. Proc. Amer. Soc. Hort. Sci. 85: 17-19. 1964.

In one year's tests, N-dimethyl amino succinamic acid (B-Nine) applied to apple trees several days after full bloom largely prevented the development of scald on the fruit in storage and significantly extended the shelf life of the fruit after removal from storage. The treated fruit remained firmer than the checks in storage and softened at a slower rate when ripened. The B-Nine treatment resulted in less water soluble pectin, and slightly more total pectin in the fruit after storage.

CRD, ARS, USDA, Wash. State U., Wenatchee, Wash.

142. Mortensen, W. P., Baker, A. S., and Dermanis, P. EFFECTS OF CUTTING FREQUENCY OF ORCHARDGRASS AND NITROGEN RATE ON YIELD, PLANT NUTRIENT COMPOSITION, AND REMOVAL. Agron. J. 56(3): 316-320. 1964.

A field study was conducted over a 4-year period, 1957-60, to evaluate the effects of N fertilizer rates and cutting frequencies on orchardgrass growing on a Saltan silt loam at Puyallup, Wash. The N rates varied from 0 to 300 lb./A. annually with 3 cuttings and from 0 to 500 lb./A. with 5 cuttings. The authors concluded that:

1. Dry matter response was linear up to relatively high N rates, but declined appreciably above 200 lb. N/A. with 3 cuttings and above 300 lb. N/A. with 5 cuttings. Yield increases of about 300 percent were obtained with the highest rate of N in both cutting frequencies.
2. Forage production was improved by less frequent cutting.
3. The greatest difference between the cost of N and value of the yield increase occurred at about 300 lb. N/A. with both cutting frequencies.
4. The efficiency of N fertilizer in crude protein production was constant, regardless of N rate or cutting frequency. The mean recovery of applied N by forage in the form of crude protein was 52 percent over the 4 years.
5. The percentage of crude protein in the forage increased markedly at the higher rates of N fertilization.
6. The removal of Ca, Mg, K, Na, and P in forage was directly related to N rate and dry matter yields. Of these, K was the most likely to become limiting under massive fertilization of grass with N as indicated by both plant removal and soil tests.
7. The percentages of Ca and P in the forage were reduced slightly by N fertilization while Mg was not influenced. Large reductions in percent K accompanied by a large increase in Na occurred with N fertilization. It appeared that this resulted from a tendency by orchardgrass to maintain cation equivalency.
8. Possible toxic levels of No_3-N occurred in the forage cut 5 times per season and receiving 100 pounds of N per application (a total of 500 lb./A. per year). Toxic levels never occurred in forage cut 3 times or at the first cutting in forage cut 5 times per season.
9. Large and significant yield responses were obtained from residual N in 1961 and 1962 from applications of NH_4NO_3 during the years 1957-60.

Western Wash. Expt. Sta., Puyallup, Wash.

143. Stallcup, O. T., Davis, G. V., and Ward, D. A. FACTORS INFLUENCING THE NUTRITIVE VALUE OF FORAGES UTILIZED BY CATTLE. Ark. Agr. Expt. Sta. B. 684, 44 pp. 1964.

The chemical composition of forage from Ace wheat plants harvested from the early vegetative stage to the hard dough stage was investigated. A decline in crude protein and an increase in crude fiber was observed with advancing maturity of plants while in the vegetative stage. Nitrogen-free extract increased and crude fiber decreased with development of the grain in the heads of the plants.

Chemical composition, digestibility, and TDN content were determined for sudan grass forage at three stages of maturity. Differences in the digestibility of crude protein, cellulose, crude fiber, NFE, organic matter, and energy were significant between the stage when plants were 18 to 24 inches in height and the boot to early head stage. The TDN content was significantly higher at the earlier stage of growth. Digestibilities of crude fiber, NFE, and organic matter were significantly higher for plants 18 to 24 inches in height as compared to plants 36 to 48 inches in height.

Data on the chemical composition of rye, crimson clover, orchard grass, and Ladino clover harvested at three dates were presented. Ladino clover forage changed but little in chemical composition during the 4-week period. Crude protein declined in the other plants studied but it was mainatined at a much higher level in the crimson clover and orchard grass than in the rye forage.

The chemical composition and the crude fiber characteristics of a wide variety of forage plants harvested in 1958 were determined. Cellulose made up from 59.7 to 83.6 percent and lignin from 1.4 to 18.1 percent of the crude fiber dry matter. A combined figure representing the total of the cellulose and lignin made up from 69.6 to 91.0 percent of the total dry matter.

Characteristics of the crude fiber of Arkwin oat forage cut from March 10 to June 2 were investigated. Cellulose made up an average of 83.7 percent of the crude fiber dry matter. The crude lignin made up an average of 4.9 percent of the crude fiber dry matter, and the crude protein content averaged 0.7 percent. Recovery in the crude fiber fraction of the total lignin in the plant averaged 32.1 percent.

Data were presented on the physical characteristics and chemical composition of corn plants harvested from the tassel stage to the grain-in-dent stage. Trends observed to take place with advancing maturity included: (1) An increase in dry matter content of the plant; (2) a decrease in the realtive percentages of dry matter present as leaves and stalks; (3) an increase in the realtive percent of dry matter present as ears; and (4) a general trend for the crude protein (dry basis), crude fiber, cellulose, and ash to decrease. Ether extract, nitrogen-free extract, and energy increased, particularly after grain formed on the ears.

Digestion trials were conducted to determine the nutritive value of certain corn and sorghum hybrids. The TDN values were 66.0, 67.2, 78.8, 72.5, and 75.3 percent for silages made from sorghum hybrids Ark. Experimental 1 and 2, and AKS hybrids 38, 41, and 42, respectively. TDN values in silages made from corn hybrids Dixie 82, Dixie 82 stalks, Dixie 29, dwarf corn, and Funk's G-711AA were 63.1, 54.7, 66.2, 82.9, and 72.2 respectively. Coefficients of digestibility for crude protein were 52.0, 52.2, 66.2, 69.9, and 61.2 percent for silages made from the five sorghum hybrids, respectively. The coefficients of digestibility of crude protein for corn and silages made from Dixie 82, Dixie 82 stalks, Dixie 29, dwarf corn, and Funk's G-711AA were 24.7, 2.7, 22.0, 73.6, and 29.6 percent, respectively.

Digestion trials were conducted on three alfalfa hays, hop clover-cheat hay, and wheat straw. Alfalfa hay conditioned by a hay crimper during the harvesting process had lower percentages of crude protein and ash and a higher percentage of crude fiber than alfalfa hay that was not conditioned. The hop clover-cheat hay had a TDN value comparable to that observed for the alfalfa hays studied but the digestibility of crude protein was much less.

The addition of starch or urea to wheat straw did not significantly alter the digestion coefficients for dry matter, crude fiber, ether extract, cellulose, and energy, nor did it alter significantly the TDN content. The addition of urea significantly increased the digestibility of protein and the retention of nitrogen by steers. The addition of starch increased the digestibility of nitrogen-free extract.

The intake data and silage quality scores indicated that silages made from alfalfa and oats forages were not benefited by adding the preservatives studied.

The proximate analyses of crude lignin obtained from six hays, oat straw, and Indulin A were presented. Adding Indulin A to a molasses-hay ration at the rate of 4.76 percent did not significantly reduce the digestibility of the other components of the ration. Adding Indulin A to cellulose in artificial rumen flasks at rates of 0, 15, 20, and 25 percent of Indulin A did not significantly influence cellulose digestion.

Tables and bibliography.

Agr. Expt. Sta., Div. Agr., U. Ark., Fayetteville, Ark.

144. Vose, P. B. VARIETAL DIFFERENCES IN PLANT NUTRITION. Herbage Abs. 33(1): 1-13. 1963.

A review of the literature and a discussion were given on varietal differences in plant nutrition.

Bibliography of 189 articles.

Seoul Natl. U., Suwon, Korea.

Soil Classification

SEE ALSO 23, 42, 55, 75, 77, 91, 92, 93, 94, 95, 99, 100, 103, 104, 105, 106, 112, 113, 114, 117, 130, 139, 142, 145, 161, 163, 164, 166, 168, 173, 176, 206, 207, 258, 285, 295, 305.

145. Tarrant, R. F. FOREST SOILS RESEARCH IN OREGON AND WASHINGTON: A BIBLIOGRAPHY WITH ABSTRACTS THROUGH 1963. U.S. Forest Serv. Res. Note PNW 15, 29 pp. 1964.

All published forest soils research done in Oregon and Washington—from 1914 through 1963 were referenced and summarized.

Most forest soils research in the Pacific Northwest started after World War II. Of 139 references listed, only 11 were published before 1947.

Pacific Northwest Forest and Range Expt. Sta., FS, USDA, Portland, Oreg.

146. Schwantes, A. J. MOVEMENT OF FIELD STONES TOWARD THE SURFACE. Trans. ASAE 7(4): 427-431. 1964.

In many areas, land cultivated for agricultural purposes is infested with field stones. These are bothersome and interfere with operations incident to planting, caring for, and harvesting of the crop. Most serious interference is with plowing and cultivating. On cropped land requiring normal cultivation, it is common practice to remove loose surface stones. Seldom, is the task of removing stones from a particular field really complete. New crops of stones come along and further removal is necessary at intervals of one or more years.

The factors which might influence the tendency for field stones to appear to rise toward and above the surface in a cultivated field were determined. The three sites selected were located at Duluth, Grand Rapids, and Park Rapids, Minn. The site were selected in areas where they might not be disturbed by implements or other farm activity over a period of years. The following conclusions were made:

1. Stones buried under certain conditions of soil type and moisture content continued to settle for several years.
2. The elevation of field stones did not change over the years.
3. It was concluded that frost did not affect the vertical movement of field stones. Data on depth of frost at each of the three locations, showed that at all locations one-half or more of the subsurface stones were below the influence of frost. It was impossible to find any difference between the behavior of deep and shallow subsurface stones.
4. Stones resting on the surface behaved no different from those below the surface, either shallow or deep.
5. Where field stones appeared to be moving toward the surface, it was concluded that this phenomenon was the result of erosion of the surface and/or some compression of the upper portion of the soil horizons.

U. Minn., St. Paul, Minn.

147. Barratt, B. C. A CLASSIFICATION OF HUMUS FORMS AND MICRO-FABRICS OF TEMPERATE GRASSLANDS. J. Soil Sci. 15(2): 342-356. 1964.

The humus form is recognized in a soil profile as the group of A horizons in which organic matter is concentrated, and it is thus the upper part only of the genetic humus type, the true measure of which is the complete organic profile extending into B and C horizons. Grassland humus forms were subdivided on a basis of field morphology into two groups: Mull, in which the organic residues are largely incorporated as an intimate clay-humus mixture; and mor, in which organic residues in varying stages of decomposition overlie the mineral soil with a sharp boundary but may show weak mechanical admixture of mineral grains. A mor-like mull intergrade was recognized where the mull was very high in intimately incorporated organic matter.

According to variation in horizon thickness, structure, and consistence, the following sixteen humus forms were recognized: Strongly granular; weakly granular; massive or blocky; fine; matted; laminated and lenticular mulls; strongly granular, weakly granular, and laminated mor-like mulls; and granular, massive, matted, laminated, banded, and mullized mors. Where mineral grains were very abundant in mor a sandy phase was recognized.

Each layer or horizon of a humus form may have one or more distinct micro-structures or fabrics. Twelve fabrics have so far been recognized under grassland; weak mull humus, strong mull humus, mull-like moder, mull-like rendzina moder, leached mull-like rendzina moder, silica moder, swollen moder, rendzina moder, leached rendzina moder, raw soil humus, sclerotial humus, and raw humus.

Soil Bureau, Dept. Sci. and Indus. Res., Wellington, New Zealand.

148. Sparrow, G. N., Long, F. L., and Daniels, J. M. WATER CONTROL ON BLADEN SOIL. Trans. ASAE. 7(3): 313-315. 1964.

Water management was studied on Bladen fine sandy loam. The Bladen soil series is found only in the Atlantic Coast flatwoods of the Southeast. The soils are humic-gleys which were formed from thick beds of acid clays and heavy sandy clays resting on sand. The location and general structure of the soils is such that both surface and profile drainage are seriously restricted.

Water movement vertically in the Bladen profile may vary as to rate but, in most cases, is extremely slow. The attainment of equilibrium in the soil-water system often is so slow following rains as to deter use of the land agriculturally. By the same token, lateral movement of soil water is so affected by unpredictable variation in permeability that profile drainage into ditches is ineffective.

Surface drainage systems appear to be the only effective means of draining Bladen soil. Rapid surface removal of water will permit use of the land for forage and pasture. Satisfactory production can be assured by the proper selection of forage plants and by their adequate fertilization. Crop production requiring annual or seasonal preparation is usually extremely risky. However, soybeans produce well.

F. L. Long, SWCRD, ARS, USDA, Florence, S.C., 29501

EROSION CONTROL

Wind and Water Erosion

SEE ALSO 18, 23, 24, 25, 26, 33, 206, 256, 267.

149. Young, R. A., Mutchler, C. K., and Wischmeier, W. H. INFLUENCE OF ROW DIRECTION AND TYPE OF VEGETAL COVER ON THE SLOPE-SOIL LOSS RELATIONSHIP. Trans. ASAE 7(3): 316-317, 320. 1964.

Interrelation of effects of percent slope, row direction, type of vegetation, and stage of crop growth on soil erosion were investigated in a 3-year study using simulated rainfall on field plots.

For summarization and interpretation of the data, the crop year was divided into the five crop-stage periods defined by Wischmeier for evaluation of the cropping-management factor in the erosion equation. They were as follows: (1) Period F rough fallow —Turn plowing to seeding; (2) period 1 seedbed—Seeding to 1-month thereafter; (3) period 2 establishment—One to two months after spring seeding; (4) period 3 growing crop—Period 2 to crop harvest; and (5) period 4 residue or stubble—Crop harvest to turnplow or new seeding.

Data were obtained during crop stage periods 1, 2, and 3 for corn and crop stage periods 1, 3, and 4 for oats. These periods accounted for 89 percent of the annual erosive potential of rainstorms for corn and 67 percent for oats.

The major factors explaining soil-loss variance were slope, row direction, percent cover, antecedent moisture, and first-order interactions of these variables.

Interaction of slope effect with row direction was highly significant, indicating that even within the 4 to 10-1/2 percent slope range, the effectiveness of across-slope seeding and tillage was significantly influenced by percent slope.

Percent of effective land cover significantly influenced the relationships of both slope and row direction to soil loss. The effect of percent slope on soil loss was greatest during the seedbed period and least in oat period 4. With corn planted up-and-down slope, the decrease in slope effect as the season progressed was slight.

Curvature of the slope-soil loss relationship was greater when the two crops were planted across slope because the effectiveness of row direction was influenced by percent slope.

On the narrow rectangular plots used, across-slope tillage and planting was more effective than indicated by the field contour factors now in use. With respect to steepness of slope, its effectiveness was greatest, on a percentage basis, on the medium (7-1/2 percent) slope, although total soil loss increased with percent slope throughout the range of slopes used in the experiment. With respect to crop and stage of growth, its effectiveness was greatest in corn period 2 and was insignificant in oat period 4.

Total soil loss from all the plots farmed across slope was 27 percent of the total from all plots farmed up-and-down slope.

SWCRD, ARS, USDA, Morris, Minn., 56267

150. Rogers, J. S., Barnett, A. P., and Cobb, C., Jr. AN EVALUATION OF FACTORS AFFECTING RUNOFF AND SOIL LOSS FROM SIMULATED RAINFALL. Trans. ASAE 7(4): 457-459. 1964.

Runoff and soil loss studies using the rainulator were conducted on Cecil sandy loam to sandy clay loam soils. Rainfall intensities of 1-1/4, 2-1/2, and 5 in. per hour, rainfall amounts of 1-1/4, 2-1/2, 3-3/4, and 5 in., and slope lengths of 35, 55, and 75 ft. were evaluated over a 2-year period. Regression techniques were used to determine the effects of various factors and combinations of factors on runoff and soil loss.

Seventy percent or more of the variation in soil loss data was explained by rainfall intensity multiplied by rainfall amounts. In series II tests the slope length exponent was 0.7, whereas in series III tests the slope length exponent was zero. There were indications of interaction effects of slope length with both rainfall intensity and rainfall amounts on soil loss.

Rainfall amount explained approximately 89 percent of the variation in total runoff. There was, however, some interaction of rainfall intensity and amount. Runoff increased with increased initial moisture content of the soil.

None of the soil physical and chemical characteristics measured were effective in explaining variation in either runoff or soil loss.

U. Ill., Urbana, Ill., 61803

Terracing

151. Launchbaugh, J. L. SEEDING WESTERN WHEATGRASS WITH INCREASING RATES OF PERENNIAL RYEGRASS OR SMOOTH BROME IN WATERWAYS. J. Range Mangt. 17(5): 245-248. 1964.

Western wheatgrass was planted at 8 lb./A. with increasing rates of perennial ryegrass and smooth bromegrass in a new waterway. Perennial ryegrass increased until the second or third season, then was replaced by western wheatgrass. Smooth bromegrass increased and dominated all plots. It seems advisable to use short-lived, unadapted plants such as perennial ryegrass as companion species to western wheatgrass.

Fort Hays Br., Kans. Agr. Expt. Sta., Hays, Kans.

Critical Areas

SEE ALSO 169, 206.

152. Ashby, W. C. VEGETATION DEVELOPMENT ON A STRIP-MINED AREA IN SOUTHERN ILLINOIS. Trans. Ill. Acad. Sci. 57(2): 78-83. 1964.

The study areas were stripped in 1935 in Perry County about 4 miles west of DuQuoin, Ill. In 1938 and 1939, black locust (Robinia pseudoacacia) and shortleaf pine (Pinus echinata) were planted in separate adjacent areas. Eight years later two adjacent one-half acre experimental plots in each overstory area were further underplanted with nine tree species (Mather et al., 1947). The black locust (many riddled by locust borer) then averaged about 22 feet in height with 1,200 survivors from the original 2,700 trees per acre. The shortleaf pine averaged less than 6 feet in height with about 700 remaining from the original 1,200 per acre.

By 1962-63 further mortality and growth of the remaining trees had taken place. Approximately 400 black locust and 650 pine trees per acre remained. The locust continued to show damage from locust borer and the pine from tip moth and other causes. Many of the pines appeared to have low vigor. Localized areas in both the black locust and the pine had enhanced coverage from the growth of those underplanted trees which survived and from natural tree invasion. The canopy was closed over much of both areas.

The ground cover was denser and taller in the areas originally planted to black locust. There was knee-high herbs over much of this area. In contrast, the ground cover was scanty over much of the pine stand, with a pine needle carpet generally evident.

Twenty-five species were distinctive to the black locust area and 30 to the pine area, with 26 species common to both.

The second ingredient of invasion, a suitable habitat, differed for the two areas. Test species on the two soils in pot culture showed a highly significantly greater growth on the soil from the black locust than from the pine area (Baker and Ashby, 1963). This difference was eliminated by fertilizing 200 lb. N/A. Nodules were found on the black locust roots. The greater nitrogen nutrient capital of the black locust soil would be a major factor favoring the growth of virtually all species. Actually, herbaceous legumes (Cassis, Crotalaria, Desmodium) were relatively much more important in the pine, through still sparse except for the localized patches of sweet clover in openings.

The essentially continuous mat of pine needles would be a deterrent to establishment of some species.

Southern Ill. U., Carbondale, Ill.

153. Limstrom, G. A. REVEGETATION OF OHIO'S STRIP-MINED LAND. Ohio J. Sci. 64(2): 112-119. 1964.

The success of strip-mine revegetation is influenced greatly by the composition of the basic materials and the way these materials are manipulated in mining and grading, site conditions after mining and grading, and planting techniques. Site conditions can be accurately appraised only after mining and grading operations are completed, and include such physical characteristics of spoil materials as texture and aggregation, spoil acidity, bank topography, and presence or absence of grading, and cover. Major planting problems to be resolved include the choice of species, planting methods, planting-stock quality, and erosion control.

Central State Forest Expt. Sta., FS, USDA, Columbus, Ohio.

SOIL MANAGEMENT

Cropping Practices

SEE ALSO 283, 300.

154. Hedlin, R. A., and Ridley, A. O. EFFECT OF CROP SEQUENCE AND MANURE AND FERTILIZER TREATMENTS ON CROP YIELDS AND SOIL FERTILITY. Agron. J. 56(4): 425-427. 1964.

Highest wheat yields were obtained on fallow land. Higher yields of wheat were obtained following flax and corn than following oats, barley, or spring rye. Oats gave higher grain production than wheat. The same was true of barley until the most recent 6-year period when barley yields declined relative to those of wheat and oats.

The manure applications resulted in substantial yield increases, particularly of barley grown following corn. Low barley yields in Manitoba in recent years may, in part at least, be due to failure to maintain soil fertility. Flax yields were not greatly increased by manure treatments.

Manure increased readily extractable phosphorus as did ammonium phosphate treatments. However, only the manure treatment resulted in a residual effect on crop yields.

U. Manitoba, Winnipeg, Canada.

155. Robinson, D. W. NON-CULTIVATION SYSTEMS FOR SMALL FRUITS AND VEGETABLES. Weeds 12(4): 245-251. 1964.

In the last few years, the possibility of growing small fruits and several vegetable crops without any soil disturbance has been demonstrated. On many soil types, crop yield has been unaffected and has sometimes shown a slight increase compared with traditional cultivation. Advantages of non-cultivation include: The possibility of increasing crop uniformity and yield by using closer row spacings and completely new methods of crop production; the avoidance of injury to surface-feeding roots; decreased risk of frost; and easier mechanical harvesting of some crops.

In small-fruit plantations, the weed problem has greatly diminished after about 3 years, because of non-disturbance of seeds lying below the germinating zone and the absence of a "seed-bed".

While the surface crust that sometimes forms where the soil is not disturbed may affect plant growth in certain circumstances, no evidence was obtained in recent experiments in Britain that a crust was detrimental to the growth of established plants. However, water infiltration on bare son-cultivated soil was sometimes retarded and increased run-off occurred on sloping sites. Due to the wide diversity of soil types, climatic conditions, and crop response, it is impossible to generalize about the effect of eliminating cultivation. Since the advantages are considerable and the disadvantages can often be overcome, it seems likely that non-cultivation practice will extend to many horticultural crops in the future.

Hort. Cent., Loughgall Co., Armagh, Northern Ireland.

156. Jansen, L. L. SURFACTANT ENHANCEMENT OF HERBICIDE ENTRY. Weeds 12(4): 251-254. 1964.

Selected, representative research on surfactants, herbicide penetration, and plant cuticles was reviewed briefly. New evidence was presented that surfactants influence the activity of herbicides in oil sprays as spectacularly as in aqueous sprays. Most of the experimental facts about surfactants were integrated in a blanketing theory for entry of herbicides by separate hydrophilic and lipophilic pathways.

CRD, ARS, USDA, Beltsville, Md., 20705

157. Robocker, W. C., Kerr, H. D., and Bruns, V. F. CHARACTERISTICS AND CONTROL OF SWAINSONPEA. Weeds 12(3): 189-191. 1964.

Swainsona salsula is an unpalatable legume of Asiatic origin which spreads by seed and lateral roots and has become a problem in some poorly drained, marshy, or saline areas of several western states. Its growth characteristics indicate a high potential for establishment along stream banks, irrigation canals, wasteways, pastures, and meadows with high water tables, and other poorly drained areas. Its agressiveness results in its dominance on such areas. Silvex, 2,4-D, or 2,4,5-T applied at 2 lb./A. for 2 or more years in succession controlled swainsonpea satisfactorily on cropped land. 2,3,6-TBA was also effective.

CRD, ARS, USDA, Pullman, Wash., 99163

158. Linscott, D. L. DEGRADATION OF 4-(2,4-DICHLOROPHENOXY)-BUTYRIC ACID [4-(2,4-DB)] IN PLANTS. Agr. and Food Chem. 12(1): 7. 1964.

Studies on beta oxidation of fatty acids and research leading to the development of 4-(2,4-DB) as a herbicide were reviewed. In greenhouse studies, 85 to 93 percent of the C-14-labeled herbicide applied to legumes disappeared within 30 days after treatment. Simulated rainfall accelerated herbicide removal. Herbicide applied to legumes was not found in regrowth after a clipping. Fermentation of legumes for 45 days in small tubes resulted in substantial decomposition (67 percent) of 4-(2,4-DB).

CRD, ARS, USDA, Cornell U., Ithaca, N.Y., 14850

Crop Residue Management

SEE ALSO 98, 106, 118.

159. Ramig, R. E., and Mazurak, A. P. WHEAT STUBBLE MANAGEMENT: I. INFLUENCE OF SOME PHYSICAL PROPERTIES OF A CHERNOZEM SOIL. Soil Sci. Soc. Amer. Proc. 28(4): 554-557. 1964.

Four methods of wheat stubble management (burn and plow, plow, one-way disk, and subsurface-till) in an alternate wheat-fallow system on a Chernozem soil were studied for 12 years. Plots were split, with one-half of each plot receiving N fertilizer. Twelve years of subsurface-tilling or one-way disking substantially increased the geometric mean diameter of water-stable aggregates and decreased the bulk density of the surface soil as compared with plowing or burning and plowing. The ratio of water entry, 10 minutes to 120 minutes, was substantially lower in wheat plots that had been subsurface-tilled or plowed than where the plots had been burned and plowed or one-way disked. Application of N fertilizer did not affect the physical properties measured.

SWCRD, ARS, USDA, Pendleton, Oreg., 97801

160. Clement, C. R., and Williams, T. E. LEYS AND SOIL ORGANIC MATTER. J. Agr. Sci. 63(4): 377-383. 1964.

The increase in soil carbon was assessed in arable land sown to different leys variously managed. The authors concluded that:

1. Under swards cut for herbage conservation, carbon in the top 15 cm. of soil increased by about 0.05 percent each year. Although an increase of 0.03 percent was found immediately under drills of cocksfoot growth for seed production, there was no increase midway between the drills and, for a given area of land, the carbon increment under such row-crops was probably similar to that under cut swards.
2. When all the grass grown was grazed, carbon increased by 0.06-0.07 percent each year; taking hay and then grazing the aftermath gave increments intermediate between wholly grazing or cutting the herbage.
3. More carbon was accumulated under ryegrass/white clover than under cocksfoot/white clover swards. In another experiment, differences in carbon levels within a wider range of ley species could not be distinguished.
4. The amount of nitrogen fertilizer applied each year to both grazed and cut leys had no measurable effect on the increase in soil carbon.

5. After 3-4 years under grass, the increase in carbon was confined to the top 2-3 cm. of soil. Below this depth, root growth seemed to be only sufficient to replace carbon lost during decomposition.

Grassland Res. Inst., Hurley, Berkshire, Great Britain.

Tillage

SEE ALSO 159, 234, 258, 267, 274, 277.

161. Luttrell, D. H., Bockhop, C. W., and Lovely, W. G. THE EFFECT OF TILLAGE ON SOIL PHYSICAL CONDITIONS. 6th Internatl. Congress Agr. Engin. III: 795-796. 1964.

The effect of some tillage operations on the soil physical factors were determined. The changes in bulk density, clod size, and surface roughness were measured before and after the tillage operations. Soil temperature and moisture were measured periodically for several days following tillage operations. Various combinations of a moldboard plow, disk harrow, and spike-tooth harrow were used as tillage operations.

A total of seven experiments were performed on three different soil types. Four were performed on the same soil type at one location where the moisture content before tillage was varied. Plowing reduced the bulk density of soil by 0.3 g./cc. Various combinations of disking and harrowing tended to increase the soil density after plowing but not a great deal, and there was little or no difference between disk and spike-tooth harrowing or between one and several diskings. Clod size distributions followed the same pattern. The technique of calculating a roughness coefficient was successful and followed the same pattern as bulk density and clod size. Temperature and moisture measurements showed little or no effect due to tillage operations. Using a disk harrow or a spike-tooth harrow immediately after plowing caused only slight changes in bulk density, clod size, an surface roughness. Performing more than one of these secondary tillage operations appeared to be wasted effort.

U. Tenn., Knoxville, Tenn., 37901

162. Burnside, O. C., Fenster, C. R., and Wicks, G. A. INFLUENCE OF TILLAGE, ROW SPACING, AND ATRAZINE ON YIELD COMPONENTS OF DRYLAND SORGHUM IN NEBRASKA. Agron. J. 56(4): 397-400. 1964.

RS 501 sorghum was grown at Lincoln, North Platte, and Alliance, Nebr., during 1961-62 to determine the effect of tillage, atrazine, hand-weeding, and row spacing on various characters influencing sorghum yield.

Those characters showing a positive correlation ($P = 0.01$) with sorghum yield were sorghum height, forage yield, sorghum population, sorghum heads per acre, individual head weight, percentage seed moisture at harvest, bushel weight, weight of 100 seeds, and germination percentage. Characters negatively correlated ($P = 0.01$) with sorghum yield were weed yields and percentage lodging.

Tillage treatments as compared with untilled plots increased sorghum yields, sorghum height, sorghum heads per acre, heads per plant, individual head weight, and seed moisture at harvest; and decreased weed yields and sorghum population. Other characters were not significantly affected by tillage treatments.

Hand weeding as compared with no weed control increased sorghum yield, sorghum height, forage yield, sorghum population, sorghum heads per acre, heads per plant, individual head weight, seed moisture at harvest, and bushel weight; and decreased weed yields and lodging.

Pre-emergence atrazine applications at 2 and 4 lb./A. as compared with no weed control increased sorghum yields, heads per plant, individual head weight, and seed moisture; and decreased weed yields, sorghum height, lodging, forage yields, sorghum population, sorghum heads per acre, and bushel weight.

Narrow row spacings (10 and 20 inches) as compared with wider row spacings (30 and 40 inches) increased lodging, forage yields, sorghum population, and sorghum heads per acre; and decreased weed yields, sorghum height, heads per plant, individual head weight, seed moisture, and weight of 100 seeds.

U. Nebr., Col. Agr., Agr. Expt. Sta., Lincoln, Nebr.

Fertility Requirements for Conservation Farming

SEE ALSO 54, 87, 90, 91, 92, 95, 104, 105, 106, 110, 112, 113, 114, 115, 116, 120, 121, 122, 123, 124, 125, 126, 127, 128, 129, 130, 131, 134, 136, 138, 139, 140, 142, 143, 148, 154, 160, 177, 179, 206, 207, 216, 231, 258, 270, 283.

163. Figerella, J., Vicente-Chandler, J., Silva, S., and Caro-Costas, R. EFFECTS OF PHOSPHORUS FERTILIZATION ON PRODUCTIVITY OF INTENSIVELY MANAGED GRASSES UNDER HUMID TROPICAL CONDITIONS IN PUERTO RICO. J. Agr. U. Puerto Rico 48(3): 236-242. 1964.

The effects of phosphorus applications on yields and phosphorus content of otherwise well-fertilized tropical grasses growing on three typical soils of the Humid Region of Puerto Rico were determined.

Napiergrass responded strongly in yield to applications of 150 pounds of P_2O_5 per acre yearly on both Múcara and Catalina clay soils at Orocovis. The phosphorus content of the forage increased with applications of up to 300 pounds of P_2O_5 per acre yearly on both soils.

On the other hand, Napier, Guinea, and Pangola grasses, growing on a Fajardo clay formerly in moderately fertilized sugarcane for many years, did not respond in yield or phosphorus content to applications of phosphorus over a 5-year period.

Various methods of determining "available" soil phosphorus did not give satisfactory results with these soils.

SWCRD, ARS, USDA, Agr. Expt. Sta., U. Puerto Rico, Rio Piedras, Puerto Rico, 00928

164. Mackenzie, A. F., and Amer, S. A. REACTIONS OF IRON, ALUMINUM AND CALCIUM PHOSPHATES IN SIX ONTARIO SOILS. Plant and Soil 21(1): 17-25. Aug. 1964.

Surface samples of six Ontario soils were selected to provide a range in pH, texture, and carbonate content. Phosphorus was added to the soil samples at the rate of 200, and 2,000 lb. P_2O_5/A. and the inorganic phosphates associated with aluminum (Al—P), iron (Fe—P), and calcium(Ca—P) were analysed 15, 30, and 335 days after treatment. Samples of the check soils were leached with the equivalent of 7 liters of soil-percolated water and then analysed for phosphate fractions.

In five soils with added phosphorus, the Al—P fraction increased at both rates of added phosphorus, Fe—P increased only at the higher rate of added phosphorus, and Ca—P did not increase at either rate. In the sixth soil (69.9 percent $CaCO_3$ equivalent), Ca—P increased at both rates of added phosphorus, but proportionately less than the water-soluble phosphorus. These changes in phosphorus values existed relatively unchanged for 335 days after the addition of phosphorus. Leaching generally removed phosphorus from all phosphorus fractions. At or below pH 7.1 (soil paste), the Al—P decreased proportionately more than the Fe—P and Ca—P. Above pH 7.1, the Ca—P decreased proportionately more than the other two fractions upon leaching.

McGill U., Macdonald Col., Quebec, Canada.

165. Mack, H. J., Fang, S. C., and Apple, S. B., Jr. EFFECTS OF SOIL TEMPERATURE AND PHOSPHORUS FERTILIZATION ON SNAP BEANS AND PEAS. Proc. Amer. Soc. Hort. Sci. 84: 332-338. 1964.

Five experiments were conduced in the greenhouse on snap beans and peas in which soil temperatures of 62° and 78° F. were maintained in two experiments and soil temperatures of 54°, 62°, 70°, and 78° F. maintained in three experiments. Phosphorus rates were 0 and 70 lb.P/A. except in one experiment P rates were as high as 280 lb./A.

In the five experiments, an increase in soil temperature from 54° to 78° F. increased dry weights of snap beans from 60 to 850 percent, while dry weights of peas were increased little or reduced from 7 to 18 percent. A similar trend for P content of plants with soil temperature was found.

Increases in dry weight and P content of peas from applications of P fertilizer were, in general, similar at the four soil temperatures. Applications of high rates of P fertilizer did not compensate for the inhibitory effect of the lowest soil temperature (54° F.) on growth of snap beans. Increases in dry weights and total P recovered in plants from P fertilization were greater for beans than for peas.

Responses of plants to added P and to an increase in soil temperature were usually greater in experiments conducted under conditions of longer duration and higher intensity of light in spring months than under conditions of lower light intensity and shorter duration found during winter months.

Oreg. State U., Corvallis, Oreg.

166. Lorenz, O. A., Tyler, K. B., and McCoy, O. D. PHOSPHATE SOURCES AND RATES FOR WINTER LETTUCE ON A CALCAREOUS SOIL. Proc. Amer. Soc. Hort. Sci. 84: 348-355. 1964.

Four P sources were compared for winter lettuce on an alkaline, calcareous soil of California's Imperial Valley. Differences in yield, P uptake, and available soil P were generally small and nonsignificant at the rates commonly used in crop production. At a high application rate (210 lb. P/A.), the water-insoluble source, dicalcium phosphate, proved supior in residual effect on the second and third year's production and on available soil-P levels. Liquid sources of P applied to the soil surface as a spray were as effective as dry granular materials applied broadcast. The earliest maturity of lettuce occurred on plots receiving 210 lb. or more of P per acre. There was no effect on total yield from applications greater than 52 lb. P/A.

U. Calif., Riverside, Calif., 92502

167. McLean, E. O., and Wheeler, R. W. PARTIALLY ACIDULATED ROCK PHOSPHATE AS A SOURCE OF PHOSPHORUS TO PLANTS: I. GROWTH CHAMBER STUDIES. Soil Sci. Soc. Amer. Proc. 28(4): 545-550. 1964.

Rock phosphate was acidulated with H_3PO_4 at 0, 10, 20, 50, and 100 percent of that required to convert the rock phosphate to triple superphosphate. These materials plus a check (0 P) and H_3PO_4 alone were established as treatments on two acid soils in a 1-gallon containers in a growth chamber. The phosphate treatments were applied both in bands and mixed with the soil. In general, German millet and alfalfa yielded about as much and contained as much P in the tissue from 10 percent acidulated phosphate as from 100 percent acidulated.

Corn seedlings took up P in proportion to the relative solubilities of rock phosphate, $FePO_4$, $AIPO_4$, $Ca_3(PO_4)_2$, and KH_2PO_4 in sand. Yet they took up much less P when the phosphates were added to the soil, the amount being nearly constant regardless of the phosphate source added. This seems to be evidence for depression by common-ion action of the availability of P in comparatively insoluble phosphates whether added to or formed in the soil.

Plant response to the partially acidulated phosphates and to H_3PO_4 was discussed in the light of recent reports on phosphate reaction products in the soil. This led to the suggestion that detrimental effects of the common ion may be minimized by the partial acidulation treatments such that the environment for the soluble phosphate may be largely defined by the unreacted rock phosphate.

The comparatively favorable plant response to the partially acidulated material and the economy of its production make partial acidulation appear to have very promising practical applications.

Ohio State U., Ohio Agr. Expt. Sta., Wooster, Ohio.

168. Dallyn, S. L., and Sawyer, R. L. ANHYDROUS AMMONIA VS. AMMONIUM NITRATE AS SOURCES OF NITROGEN FOR RYE COVER CROPS ON THE POTATO SOILS OF LONG ISLAND. Amer. Potato J. 41(7): 201-207. 1964.

The effects of various cover crop treatments on the productivity of Sassafras loam has been studied at the Long Island Vegetable Research Station since 1957. One of the earlier factors under study was the use of anhydrous ammonia as a source of nitrogen for the winter rye cover crop. In this investigation, the authors concluded that:

1. Losses of ammonia from application of anhydrous ammonia were negligible when applied at a rate of 100 lb. N/A. and injected 4 inches or more below the surface.
2. Anhydrous ammonia was not as effective as ammonium nitrate as a source of nitrogen for rye cover crop. This was probably due to the fact that it was rapidly fixed in a relatively small area round the injection band.
3. There was no indication of differences between the two sources in leaching or other loss of nitrogen occurring from fall application.
4. Neither fertility treatments or the different amounts of organic matter plowed under had any effect on potato yields. Similarly, no difference in nutrient levels of the soil, as determined by complete soil test, developed.
5. Data from 3 years' experiments plus observations on methods, cost, and ease of application, strongly indicated that ammonium nitrate was superior to anhydrous ammonia as a source of nitrogen for the rye cover crops.

Long Island Veg. Res. Farm, Riverhead, N.Y.

169. Rothacher, J. S., and Franklin, J. F. FERTILIZER PELLETS IMPROVE GROWTH OF PLANTED DOUGLAS-FIR ON AN UNFAVORABLE SITE. Tree Planters' Notes 67: 9-11. Sept. 1964.

Old landings, skidroads, and similar areas, which have exposed subsoil, excessive compaction, and rocky soil, offer hostile environments for establishing natural and planted trees. The effect of fertilizer pellets was studied for survival and growth of Douglas-fir seedlings planted on an old landing.

In May, 1959, 200 2-0 Douglas-fir trees were planted. A hundred randomly selected trees were fertilized.

One commercial fertilizer pellet was placed in each planting hole and covered with a small amount of soil before a tree was planted. The pellets contained urea formaldehyde resin and superphosphate (24 percent elemental nitrogen and 2.6 percent elemental phosphorus).

Adding fertilizer pellets to planting holes significantly improved growth of Douglas-fir seedlings in all five growing seasons after planting on an old landing. But survival was the same with or without fertilizer, 87 percent.

N.C. State Col. Agr. and Engin., Raleigh, N.C.

170. Hanna, W. J., and Griffin, G. F. TESTS PROVE VALUE OF EXTRA FERTILIZER FOR SILAGE CORN. N.J. Agr. 46(3): 12-14. 1964.

For the past 3 years, fertilizer field tests with several varieties of silage corn were run on two New Jersey soils. Some effects of various fertility levels on yields for three varieties on a Nixon silt loam were reported.

Nitrogen and Potassium Interdependence—Some of the more important silage yield responses to fertilization are illustrated in Figure 1. Yield increases obtained from 100 pounds of nitrogen compared to 50 pounds ranged from 2.3 (at 129 pounds P_2O_5 and and 0 pounds K_2O) to 7.2 tons (at 155 pounds P_2O_5 and 470 pounds K_2O) per acre. Response from nitrogen increased as phosphate and potash rates approached optimum levels. Data from 1962 tests indicated that the optimum level of nitrogen was nearer 150 lb./A. than 100.

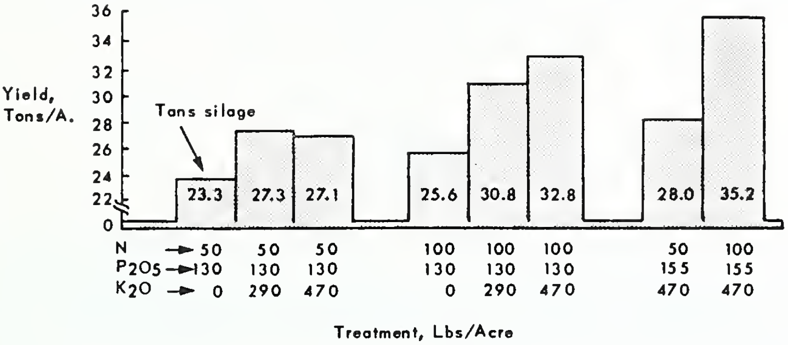

Fig. 1.—*Corn silage yields at different levels of nitrogen, phosphorus and potassium.*

A profit curve showed that the economically optimum response from phosphate was near 155 lb./A. where 100 pounds of nitrogen and 470 pounds of potash were used. Similar curves for nitrogen and potash indicated that optimum response to these elements was at, or above, the highest levels used (100 pounds of N and 470 pounds of K_2O). At these rates, the profit from using fertilizer was $95. Silage was estimated to be worth $10 per ton. The profit return per dollar spent on fertilizer was a little more than two to one.

The optimum yield (35.2 tons per acre) removed greater quantities of nutrients than the low yield (21.2 tons). The low yield removed 144 pounds of nitrogen per acre, almost three times as much as the 50 pounds of nitrogen applied. Adding an additional 50 pounds of N, along with 155 pounds of P_2O_5 and 470 pounds of K_2O, resulted in a crop removal of 6 pounds of nitrogen per acre over that of 50 pounds of nitrogen.

An average 100-bushel corn crop removed in the grain only about 100 pounds of nitrogen, 40 pounds of P_2O_5, and 20 pounds of K_2O per acre. Most of the nitrogen and phosphorus in the corn plant was in the grain, and most of the potassium was in the stover.

It is expected that fertilizer recommendations for silage corn will be revised in New Jersey to include 150 pounds of N, 150 pounds of P_2O_5, and 300 pounds of K_2O per acre where soil tests indicate low levels of phosphorus and potassium.

N.J. Agr. Expt. Sta., Col. Agr., Rutgers—The State U., New Brunswick, N.J.

171. Thompson, W. R., Jr., and Ward, C. Y. GOOD RESPONSE TO COTTONSEED MEAL ON TURF GRASSES. Miss. Farm Res. 27(3): 1-2. 1964.

One problem the average home owner has in maintaining a high quality lawn is the burning of tender turfgrasses through improper application of fertilizers. One method of eliminating this problem is through the proper use of an organic fertilizer.

Cottonseed meal (41... protein grade) contains approximately 6.6 percent nitrogen, 2.5 percent phosphate, and 1.8 percent potash. At the present time, cottonseed meal is competitively priced with other organic turfgrass fertilizers.

A test was conducted in 1962-63 on Tifgreen and Tiffine bermudagrass managed under lawn conditions (mowed at 1 inch). The experiment was in a 3 X 3 X 2 factorial experiment in a randomized complete block design with 3 replications of each grass.

The authors concluded that cottonseed meal produced comparable turf to that produced by Milorganite and ammonium nitrate. Bimonthly intervals of fertilizer application were satisfactory. None of the fertilizers tested caused adverse effects to the turfgrass. The 8-pound nitrogen rate produced higher quality turf than the 4-pound nitrogen rate.

Miss. State U., Agr. Expt. Sta., State College, Miss., 39762

172. Carroll, D. M., Erickson, C. J., and Whittaker, C. W. CEMENT KILN FLUE DUSTS FOR SOIL LIMING. Agron. J. 56(4): 373-376. 1964.

Twenty-one cement kiln flue dusts from 16 states, representing various types of dust collection and the wet and dry processes of cement manufacture, were studied for their potentialities as soil liming materials. The average determined $CaCO_3$ equivalent of the dusts was 82.36 percent. Values of the $CaCO_3$ equivalent calculated from the Ca, Mg, K, and Na contents agreed well with the determined values if due allowance was made for the sulfur and chlorine contents.

If applied at the rate of 4 tons/A., the dusts would supply, on the average, 3 times the magnesium, 6 times the sulfur, 9 times the potassium (as soluble K) and, except for one dust that would supply only 9 times, 16 times the calcium removed in a typical 5-year rotation.

In a greenhouse test on two soils, cultures limed with the dusts gave alfalfa yields and soil pH values usually not significantly different from those obtained with a pulverized limestone and frequently better than those from a relatively coarse limestone. Soil pH tended to be highly correlated with the lime-silica ratio of the dusts when these were applied at twice the lime requirement. The dusts and limestones had similar effects on the crop contents of potassium and calcium.

SWCRD, ARS, USDA, Beltsville, Md., 20705

173. MacLeod, L. B., and Bradfield, R. GREENHOUSE EVALUATION OF THE RELATIVE IMPORTANCE OF LIME AND POTASSIUM FOR THE ESTABLISHMENT AND MAINTENANCE OF ALFALFA AND ORCHARDGRASS SEEDLINGS. Agron. J. 56(4): 381-386. 1964.

Seeding alfalfa in small plugs of limed soil (pH = 7.0) in acid soil (pH = 4.6) gave higher seedling weight and higher yields of alfalfa forage and roots than seeding directly in acid soil or in plugs of unlimed soil. Yield of forage and roots was highest when alfalfa was seeded directly into limed soil (pH = 5.6). While chemical composition of the plant tissue showed significant variation due to seeding technique there was no apparent effect of this variation on yield.

When Mardin soil was limed to a pH of 5.9 the yield of alfalfa was not increased significantly by raising the soil pH to 6.4. Maintenance of the alfalfa component over a period of seven harvests was markedly influenced by rate of potassium fertilization. Potassium fertilization decreased alfalfa plant mortality significantly and increased dry matter yields of alfalfa tap roots and of fibrous roots of grass and alfalfa. Maintenance of the alfalfa component over a period of seven harvests was more dependent on an adequate supply of potassium than on increases in the soil pH above 5.9.

Canada Dept. Agr., Nappan, Nova Scotia, Canada.

174. Lambert, E. B., and San Antonio, J. P. MUSHROOM COMPOSTS PREPARED AND TESTED IN SMALL CONTAINERS. Proc. Amer. Soc. Hort. Sci. 85: 399-408. 1964.

A pilot-plant system of preparing experimental mushroom compost was described. The method was used to study the effect on mushroom yields of different durations of composting and different composting temperatures. Materials composted for short periods yielded more mushrooms per square foot of tray surface and per pound of initial dry material than composts prepared for longer periods. There were no gross differences between the yields from materials composted at temperatures above 150° F. and materials composted below 140° F.

CRD, ARS, USDA, Beltsville, Md., 20705

Salinity and Alkali Problems

SEE ALSO 51, 63, 106, 140.

175. Benz, L. C., Sandoval, F. M., Michelson, R. H., and George, E. J. MICRORELIEF INFLUENCES IN A SALINE AREA OF ANCIENT GLACIAL LAKE AGASSIZ: II. ON SHALLOW GROUND WATER. Soil Sci. Soc. Amer. Proc. 28(4): 567-570. 1964.

A study was made of the shallow ground water regime in a ridge-depression microrelief area where high salinity occurred in the ridges compared to low salinity in the depressions. Ground water movement was affected by: (1) Surface relief, which caused impounding of precipitation in the depressions; (2) greater hydraulic conductivities in the depressions; and (3) differences in moisture use due to greater tree and vegetative growth in the depressions. Water tables fluctuated from above the ground surface to depths of 10 feet. Salt concentrations of ground water were much higher in the ridges than the depressions. These differences occurred to a depth of 20 feet.

SWCRD, ARS, USDA, Grand Forks, N. Dak., 58201

176. Chaudhri, I. I., Shah, B. H., Naqvi, N., and Mallick, I. A. INVESTIGATIONS ON THE ROLE OF SUAEDA FRUTICOSA FORSK IN THE RECLAMATION OF SALINE AND ALKALINE SOILS IN WEST PAKISTAN PLAINS. Plant and Soil 31(1): 1-7. Aug. 1964.

Investigations on Suaeda fruticosa showed that it can bring about reclamation of saline and alkaline soils in certain parts of West Pakistan Plains by collecting non-saline blown soil of the sandy loam type and by absorbing large quantities of salts from the top soil. It was estimated that more than 2,400 lb. of salts were removed from one acre by a single harvest of the aerial parts in the fall. The dunes help in reclamation by diluting the salt concentration and decreasing the salt-holding capacity of the topsoil by changing the texture. It was estimated that by this method saline soils could be reclaimed within three years in southern and central parts of West Pakistan Plains which have frequent dust storms.

U. Sind, Hyderabad, West Pakistan.

177. Dregne, H. E. PLANT RESPONSE TO FERTILIZERS ON A SALINE SOIL. N. Mex. Agr. Expt. Sta. Res. Rpt. 94, 5 pp. 1964.

A greenhouse experiment was conducted to determine the effect of added salt and fertilizers on the salt tolerance of barley, cotton, and pinto beans.

All three crops yielded more at high levels of soil fertility than at low fertility levels, in the presence of low to moderate salt levels in the soil. Barley was the most salt tolerant, followed by cotton and beans, with cotton being only moderately more salt tolerant than beans.

Low levels of salt stimulated yields of barley and cotton but did not stimulate beans at the salt concentrations used.

Barley response to nitrogen, phosphorus, and potassium was similar on both non-saline and saline soils.

Tables and charts.

Agr. Expt. Sta., N. Mex. State U., State College, N. Mex.

178. George, L. Y., and Williams, W. A. GERMINATION AND RESPIRATION OF BARLEY, STRAWBERRY CLOVER, AND LADINO CLOVER SEEDS IN SALT SOLUTIONS. Crop Sci. 4(5): 450-452. 1964.

Germination was depressed markedly by osmotic pressures in excess of eight atmospheres for barley, four atmospheres for strawberry clover, and three atmospheres for Ladino clover.

Respiration rate of germinating seedlings was depressed in barley, was increased a little in strawberry clover, and was increased substantially in Ladino clover by increasing the osmotic pressure of the external environment.

The greater tolerance of barley to salinity during germination was associated with a lower respiration rate and a greater reservoir of respiratory substrate.

Jr. Author, U. Calif., Davis, Calif., 95616

179. Lunin, J., Gallatin, M. H., and Batchelder, A. R. INTERACTIVE EFFECTS OF SOIL FERTILITY AND SALINITY ON THE GROWTH AND COMPOSITION OF BEANS. Proc. Amer. Soc. Hort. Sci. 85: 350-360. 1964.

Beans were grown in the greenhouse at six fertility levels and four levels of salinization. Yields of both vines and pods increased with increasing levels of NPK at almost all saline levels. Lime had little effect on yields on non-saline soil, but greatly increased yields of pods at high salinity levels where not fertilized. Yields of both vines and pods decreased with increasing salinity, but within a given salinity level yields increased with increasing fertility. The mitigating effects of high fertility on yield reductions due to salinity were more pronounced for pods than vines.

The cation contents of the leaves and stems were more directly related to the cation content of the soil saturation extract than to the exchangeable cation content of the soil. The sum of the cations per unit dry weight of the leaves and stems increased with increasing salinity. For a given salinity level, however, the sum of the cations tended to decrease with increasing total dry weight, or yield, of plant.

The N content of both leaves and stems was affected both by salinity and fertility levels. In the stems, there was a consistent increase in N content with increasing salinity, and N values were generally lower at high soil fertility than at low soil fertility.

SWCRD, ARS, USDA, Norfolk, Va., 23501

180. Ehlig, C. F. SALT TOLERANCE OF RASPBERRY, BOYSENBERRY, AND BLACKBERRY. Proc. Amer. Soc. Hort. Sci. 85: 318-324. 1964.

Specific injury from Cl and Na was the chief cause for low salt tolerance of Indian Summer raspberries, Olallie blackberries, and Boysenberries grown in sand culture. Raspberries accumulated Cl more rapidly than blackberries and Boysenberries, and were killed or severely injured by all Cl treatments during the first year. Cl accumulation by blackberries and Boysenberries from $CaCl_2$ treatments increased markedly with each succeeding season whereas Cl accumulation from $CaCl_2$ treatments increased only slightly. The $CaCl_2$ treatments caused mortality or severe injury during the second and third years. Rates of Cl accumulation from the high-Cl treatments were much faster than rates of Na accumulation from the high-Na treatments; hence Cl injury occurred earlier and was more severe than Na injury. Higher foliar concentrations of Cl were tolerated without injury at daily maximum temperatures below 90° F. than at daily maximum temperatures above 95° F.

Salt treatments altered the K, Ca, and S contents of leaves but the alterations did not affect plant growth. Fruit production was highly variable and was significantly reduced only where severe Cl or Na injury occurred.

U.S. Plant, Soil, and Nutrition Lab., SWCRD, ARS, USDA, Ithaca, N.Y., 14850

Cover Crops and Green Manure Crops

SEE ALSO 168, 206.

181. Weinhold, A. R., Oswald, J. W., Bowman, T., Bishop, J., and Wright, D. INFLUENCE OF GREEN MANURES AND CROP ROTATION ON COMMON SCAB OF POTATO. Amer. Potato J. 41(9): 265-273. 1964.

The influence of two cultural practices on the build-up of common scab of potato was investigated. At the beginning of the test, there was a low incidence of disease distributed uniformly throughtout the field. The cultural practices were as follows: (1) Potatoes were grown intermittently in crop rotations; and (2) potatoes were grown every year and between each potato crop a cover crop was grown and incorporated into the soil as green manure.

The effect of intermittent potato cropping on the build-up of potato scab were summarized as follows: (1) No difference was observed among alternate year rotations of barley, cotton, or sugar beets. With all three crops, the rate of disease increase with each succeeding potato crop was relatively uniform. And (2) with a 3-year rotation of potatoes, sugar beets, and cotton, potato scab appeared to increase more rapidly than would be expected in view of the data from plots planted continuously to potatoes. Little could be concluded about the alfalfa 3-year, potato 1-year rotation because only four crops of potatoes were grown.

The effects of cover crops and green manure incorporation build-up of potato scab were summarized as follows: (1) Under continuous potato culture without any cover crop or green manure, the incidence of potato scab increased steadily reaching a maximum after 8 years; (2) a barley cover crop and green manure increased scab incidence to a level nearly twice that of the no cover crop control; (3) a soybean cover crop and green manure completely prevented the build-up of potato scab; (4) a Canadian pea cover crop and green manure was not appreciably different from the no cover crop control; (5) all plots except those with a soybean cover crop reached maximum scab incidence after eight crops of potatoes; and (6) although a soybean cover crop prevented disease build-up it was completely ineffective in reducing scab incidence once the pathogen was well established.

U. Calif., Berkeley, Calif., 94720

SEE ALSO 1, 12, 13, 20, 21, 22, 24, 26, 35, 41, 52, 56, 66, 104, 150, 165, 208, 209, 210, 211, 216, 224, 227, 246, 248, 249, 252, 256, 260, 268, 271, 272, 275, 280, 282.

182. Reich, B. M. SHORT-DURATION RAINFALL-INTENSITY ESTIMATES AND OTHER DESIGN AIDS FOR REGIONS OF SPARSE DATA. J. Hydrol. I: 3-28. 1963.

Maps and nomographs were developed to facilitate the estimation of short-duration rainfall-intensities for any point in South Africa. Other generalizations available for making similar estimates in other countries with even fewer pluviograph records were presented. Information on the depth-area relations, time-sequence, and other rainfall frequency characteristics were drawn together for the convenience of designers on small watersheds.

Civil Engin., Colo. State U., Fort Collins, Colo., 80521

183. Welch, L. F. VARIABLE RAINFALL, TEMPERATURE AND YEARLY TOBACCO YIELDS. Tobacco Sci. 8: 17-20. March 13, 1964.

The extent that year-to-year variation in tobacco yields could be explained by year-to-year variation in monthly rainfall and mean monthly temperature was determined by the use of multiple regression equations.

Tobacco yields increased in Georgia from 1934 to 1961 because of improved technology. This necessitated the calculation of a technology curve. The technology curve represents the yields expected if March through August monthly rainfall and mean monthly termperature had been the same as the 28-year average for the respective months.

Yield deviations from the technology curve were expressed as a function of monthly rainfall and mean monthly temperature. With linear and quadratic terms in the multiple regression equation, 43 percent of the variation due to yield deviations (from the technology curve) was accounted for by monthly March through August rainfall. Mean monthly temperature accounted for 52 percent of the variation. The regression equation was used to calculate yields, and the calculated yields were graphically compared with actual yields.

SWCRD, ARS, USDA, Watkinsville, Ga., 30601

184. Menges, R. M. INFLUENCE OF WIND ON PERFORMANCE OF PREEMERGENCE HERBICIDES. Weeds 12(3): 236-237. 1964.

Soil-surface applications of CIPC, CDEC, EPTC, sesone, and NPA were made on a Willacy fine sandy loam just before and after a 24-to-32 m.p.h. windstorm, which moved significant amounts of treated soil. All treatments were overhead-irrigated after the storm. All herbicides performed less efficiently after the wind. CIPC was found below the surface of soil only when applications were undisturbed by the wind.

CRD, ARS, USDA, Weslaco, Tex.

185. Hilgeman, R. H., Everling, C. E., and Dunlap, J. A. EFFECT OF WIND MACHINES, ORCHARD HEATERS AND IRRIGATION WATER ON MODERATING TEMPERATURES IN A CITRUS GROVE DURING SEVERE FREEZES. Proc. Amer. Soc. Hort. Sci. 85: 232-244. 1964.

The effectiveness of wind machines for protecting citrus trees from freezing was directly dependent upon existing meteorological situations, especially the velocity and temperature of the upper air. Under favorable conditions of less than 3 m.p.h. wind drift and 6° to 10° F. inversion, temperature increases in a 40 acre grove protected with 4 machines ranged from 2° to 5° F. Under ideal conditions, temperature increases amounted to about 65 percent of the inversion between 5 and 50 feet.

During three severe freezes, temperature inversion was between 4° and 5° F. and the effectiveness of wind machines was seriously reduced. Under these conditions, supplemental heat provided by flood irrigation over most of the soil surface increased temperatures 2° to 3° F. above the increase provided by machines.

Heaters placed at 1 tree and 1/2 trees on the borders and at 15/A. within the grove to provide supplemental heat with wind machines have increased temperatures 1° to 2° F. down drift above the gain provided by the wind machines alone in blocks of large trees. With a 3-5 m.p.h. wind drift, border heaters with a wind machine provided no appreciable gain in temperature updrift in a block of young trees.

U. Ariz., Citrus Expt. Sta., Tempe, Ariz.

186. Funsch, R. W. A SUMMARY OF SEASONAL TEMPERATURE AND PRECIPITATION DATA FOR THE INTERIOR FORESTED AREA OF ALASKA. U.S. Forest Serv. Res. Note NOR-9. 48pp. 1964.

A summary of seasonal temperatures and precipitation data from 22 stations in the interior forested area of Alaska was given based on 16 years of record, 1946-61. Thirty-year and longer records are commonly used for standard climatic analyses. This 16-year period is sufficiently long to effectively distinguish temperature and precipitation patterns in the vicinity of the stations. It is not, however, long enough to permit one to note cyclic phenomena or rare climatic extremes.

The seasonal period, April 1 through October 31, was used for all stations; it was selected to fully encompass the time of physiological activity in forest trees. The seasonal period was then divided into 5-or 6-day periods to allow more detailed exposure of seasonal patterns in temperature and precipitation.

Northern Forest Expt. Sta., FS, USDA, Juneau, Alaska.

187. Pruitt, W. O. CYCLIC RELATIONS BETWEEN EVAPOTRANSPIRATION AND RADIATION. Trans. ASAE. 7(3): 271-275, 280. 1964.

Although a strinkingly close relationship between evapotranspiration (ET) and net radiation (R_n) was noted on a day of variable cloudiness, results on clear, fairly calm days indicate a strong out-of-phase relationship between the two. ET/R_n ratios ranged from 0.4 to 0.7 until around noon, failing to reach 1.0 until midafternoon. Thereafter they increased sharply. This pattern of much higher ET/R_n ratios during midafternoon as compared to midmorning periods appeared to have little if any relation to differences in sensible heat transfer in the soil at the two times of the day or to changing advection effects.

The cause of the diurnal patterns of ET/R_n noted seemed most closely related to a lag of the surface temperature pattern behind the pattern of R_n. This produced higher afternoon surface temperature and surface vapor pressure with a given radiation as compared to morning hours.

On a diurnal basis, the use of ET/R_n ratios to predict the magnitude or even the presence of advection seems unwise except for cases where this ratio exceeds 1.0 over most of the daylight hours as was the case on June 1, 1960.

Results for a spring day and a fall day indicated the seasonal out-of-phase relationship noted for Davis may be largely the result of a seasonal lag of surface temperature behind radiation. This in turn could be the result of the lag in seasonal air temperature (and soil temperature) patterns behind radiation. With higher air and soil temperatures in the fall, a given level of radiation can produce warmer surface temperatures than in the spring. Factors limiting the seasonal changes of ET/R_n would be the generally higher air vapor pressures in fall months and the fact that in the absence of advestion ET/R_n cannot be appreciably higher than 1.0 for 24-hour periods.

U. Calif., Davis, Calif., 95616

188. Weather Seminar Committee. WEATHER AND OUR FOOD SUPPLY. Iowa State U. CEAD Rpt. 20, 306 pp. 1964.

The steep rate of increase in yield of grain crops in the United States since the mid-1950's has resulted in the use of the term "explosion in technology." Despite substantial reductions in acreages after 1960, the increased output per acre has just about compensated for acreage reductions. To answer important questions of the effects of weather on increased crop production, the Center for Agricultural and Economic Development invited outstanding authorities to present their ideas on the subject. The following papers were presented:

189. Wadleigh, C. H. THE NEED TO EVALUATE WEATHER.

190. Shaw, R. H., and Thompson, L. M. GRAIN YIELDS AND WEATHER FLUCTUATIONS.

191. Dale, R. F. CHANGES IN MOISTURE STRESS DAYS SINCE 1933.

192. Auer, L., and Heady, E. O. THE CONTRIBUTION OF WEATHER AND YIELD TECHNOLOGY TO CHANGES IN U.S. CORN PRODUCTION 1939 TO 1961.

193. Thompson, L. M. MULTIPLE REGRESSION TECHNIQUES IN THE EVALUATION OF WEATHER AND TECHNOLOGY IN CROP PRODUCTION.

194. Shaw, L. H., and Durost, D. D. THE WEATHER INDEX APPROACH.

195. Hurst, R. L. STATISTICAL TECHNIQUES WHICH MIGHT BE USEFUL IN FUTURE RESEARCH.

196. Willett, H. C. EVIDENCE OF SOLAR-CLIMATIC RELATIONSHIPS.

197. Bean, L. H. THE PREDICTABILITY OF CYCLES, TRENDS AND ANNUAL FLUCTUATIONS IN WEATHER AND CROPS.

198. Plamer, W. C. CLIMATIC VARIABILITY AND CROP PRODUCTION.

199. Mitchell, J. M., Jr. A CRITICAL APPRAISAL OF PERIODICITIES IN CLIMATE.

200. Kelly, B. W., and Kirkbride, J. W. FORECASTING CROP YIELDS.

201. Breimyer, H. F., and Thodey, A. R. LIVESTOCK CYCLES AND THEIR RELATION TO WEATHER AND RANGE CONDITIONS.

202. Thompson, A. T. THE SIZE OF GRAIN STOCKS THAT SHOULD BE MAINTAINED.

203. Upchurch, M. L. CONSIDERATION OF WEATHER IN FARM PROGRAM PLANNING.

204. Ezekiel, M. WORLD FOOD PROBLEMS.

205. Fox, K., Buck, R., Halcrow, H. G., Kaldor, D. R., and Soth, L. PANEL DISCUSSION OF IMPLICATIONS OF WEATHER IN AGRICULTURAL POLICY PLANNING.

Cent. Agr. and Econ. Develop., Iowa State U. Sci. Tech., Ames, Iowa., 50010

Surface Soil Removal

SEE ALSO 169.

206. Moldenhauer, W. C., Maddy, J., Schmidt, B. L., and Shrader, W. D. ESTABLISHING VEGETATION ON EXPOSED SUBSOIL IN SOUTHERN IOWA AND NORTHERN MISSOURI. U.S. Dept. Agr., Agr. Res. Serv. Agr. Inform. B. 280, 15 pp. 1964.

Extensive areas of subsoil are exposed each year in Iowa and Missouri. These occur when roads and highways are constructed, when dams and other structures are built, and when gullies are bladed in to form waterways. Unless vegetation is established, damage from silting reduces their effectiveness.

A variety of subsoil materials occur in southern Iowa and northern Missouri, but most of them are of the following three general types: Loess; glacial till or boulder clay; and shale.

Loess materials erode rapidly when exposed on slopes but are relatively easy to revegetate if lime and fertilizer requirements are met.

Most large exposures of subsoil materials in southern Iowa are composed of glacial till. This material is plastic when wet and hard and cloddy when dry. It is low in available phosphorus and potassium and very low in nitrogen.

The shales are extremely variable, ranging from material that is easy to revegetate to material on which no vegetation will grow. Most shales are low in available phosphorus and nitrogen and are difficult to work up into a good seedbed.

All these materials erode during the period of vegetation establishment. Unless erosion is controlled, large rills form. These rills take out new seedlings and leave gaps in the vegetative cover. If the gaps are large, it is often necessary to rework and reseed the area.

Because of the difficulty in establishing seedlings on raw subsoils, it was recommended that at least 2 inches of topsoil be returned after cuts are made to improve fertility relationships and the soil condition.

From 4 years of experimental work and observations of field trials of raw shales in southern Iowa, the author concluded that:

1. A mulch was essential. Wheat straw was best; oats straw was good; and manure was very good where slopes were not too steep. Straw should be anchored where possible.
2. Fertilizer was essential on raw subsoil. The lime requirement should be met. For grass-legume mixtures, 25 pounds of nitrogen and 180 pounds of potash per acre was sufficient for several years. For grass seedlings alone, 40 pounds of nitrogen and 100 pounds of phosphate should be applied annually. Fifty pounds of nitrogen per acre annually were needed for cover maintenance on grass seeded alone. Fertility requirements were reduced where topsoil was replaced.

3. A bromegrass-tall fescue-alfalfa-red clover mixture was the best grass-legume mixture. Seeding rates of 12 pounds of brome, 8 pounds of tall fescue, 6 pounds of alfalfa, and 2 pounds of red clover per acre were suggested. All legume seed should be inoculated. For grass areas alone, a bromegrass-tall fescue mixture seeded at the rates of 15 pounds of brome and 10 pounds of fescue per acre was suggested except that on areas wet for long periods, 5 pounds per acre of Reed canarygrass should be added.
4. Late March or early April or late August to early September seedings of the above mixtures were best. Between May 15 and July 1, summer cover crops should be seeded where absolutely necessary to control erosion. Sudangrass was a good summer crop on raw subsoil.
5. A companion crop was not needed where a mulch was used. In places and on occasions where a mulch was not used, rye was a good companion crop on fall seedings. Oats did well where the subsoil was mixed with topsoil and sufficient fertilizer was applied.

ARS, USDA, Info. Div., FCB, Hyattsville, Md., 20782

207. Benedict, R. H. RESTORING PRODUCTION ON LEVELED OR GRADED SANDY SOIL. Ark. Farm Res. 8(2): 6, 1964.

Approximately 6 acres of ora fine sandy loam were leveled for irrigation during the summer of 1961 on the Southwest Branch Station, Hope, Ark., to find out how long it would take to restore this land using good production practices.

All of the top soil or "A" horizon was moved to area 1 from the cut area. Area 2 was the cut area, with cuts of up to 2 feet. Subsoil or "B" horizon was moved to area 3 and placed there to a depth of 3 feet. Subsoil was placed over top soil to a depth of 1 foot on area 4.

Field and sweet corn were used as indicator crops during 1962 and 1963.

Fertilizer requirements for 1962 were 300 lb./A. of 10-20-10 on areas 1 and 3 and 500 lb./A. of 10-20-10 on areas 2 and 4, with 80 lb./A. nitrogen sidedressing on all areas. For 1963, fertilizer requirements were 300 lb./A. of 10-20-10 on areas 1 and 3, 500 lb./A. of 10-20-10 on area 2, and 500 lb./A. of 10-20-10 on area 4, with all areas sidedressed with 40 lb./A. nitrogen. In both years, lime was applied at the rate of 2.5 tons per acre.

The pH values and the yield results were given in the following tables.

Table 1. pH Values at Three Depths in the Four Areas, 1961-1963

	0- to 3-inch depth			3- to 6-in. depth			6- to 12-in. depth		
Soil area	1961	1962	1963	1961	1962	1963	1961	1962	1963
1	5.0	5.3	6.3	5.0	5.3	6.0	5.4	5.2	6.3
2	4.6	4.7	5.2	4.6	4.6	4.9	4.5	4.6	4.7
3	4.9	5.0	6.6	5.1	4.9	5.7	4.8	5.0	5.2
4	5.2	5.1	6.2	5.0	5.1	5.9	5.7	5.0	6.0

Table 2. Yields of Field Corn and Sweet Corn on the Four Areas

	Field corn[1] bu./A. shelled				Sweet corn[2], ears/A. marketable			
	Irrigated[3]		Non-irri.		Irrigated[4]		Non-irri.	
Area	1962	1963	1962	1963	1962	1963	1962	1963
1	70	65	43	83	3,060	12,243	2,398	4,785
2	22	41	17	44	4,224	10,848	2,112	7,728
3	16	67	6	37	1,090	10,812	1,360	2,364
4	16	70	6	50	5,371	9,084	4,716	1,896

[1] Funk G-711AA, yield corrected to 14% moisture content.

[2] Iona variety.

[3] Water applied in 1962, 3.5 inches; in 1963, 9.99 inches; rainfall during growing season in 1962, 17.95 inches; 1963, 22.04 inches.

[4] Water applied in 1962, 2.5 inches; in 1963, 2.7 inches; rainfall during growing season in 1962, 9.88 inches; 1963, 12.24 inches.

Agr. Expt. Sta. U. Ark., Fayetteville, Ark.

Mulching

SEE ALSO 206, 258.

208. Courter, J. W., and Oebker, N. F. COMPARISONS OF PAPER AND POLYETHYLENE MULCHING ON YIELDS OF CERTAIN VEGETABLE CROPS. Proc. Amer. Soc. Hort. Sci. 85: 526-531. 1964.

Black and brown paper and black polyethylene mulches similarly increased early and total yields of cucumbers and summer squash. Although the yield responses were economically significant for early fresh market production, problems of using either mulch material limit commercial use. Soil temperatures 4 inches under unshaded mulch were increased by polyethylene and to a lesser degree by paper. When paper was shaded by cucumber or summer squash plants, both minimum and maximum soil temperatures were decreased.

U. Ariz., Tucson, Ariz., 85721

209. Takatori, F. H., Lippert, L. F., and Whiting, F. L. THE EFFECT OF PETROLEUM MULCH AND POLYETHYLENE FILMS ON SOIL TEMPERATURE AND PLANT GROWTH. Proc. Amer. Soc. Hort. Sci. 85: 532-540. 1964.

Petroleum mulch and clear polyethylene films at band widths of 6 inches or more increased soil temperatures during the daylight hours to a depth of 6 inches and retained some soil heat during the night. Increases in soil temperatures with black polyethylene film were smaller than with either petroleum mulch or clear polyethylene film during the day; but the black polyethylene film retained more soil heat during the night.

The initial emergence of all vegetable species tested was hastened with petroleum mulch at all band widths. Petroleum mulch was beneficial in the establishment of early stands and in the hastening of maturity of many crops.

U. Calif., Riverside, Calif., 92502

210. Lippert, L. F., Takatori, F. H., and Whiting, F. L. SOIL MOISTURE UNDER BANDS OF PETROLEUM AND POLYETHYLENE MULCHES. Proc. Amer. Soc. Hort. Sci. 85: 541-546. 1964.

Petroleum mulch and polyethylene film of 0-, 3-, 6-, 12-, and 24-inch widths were evaluated for effect on retention of soil moisture during the late winter season in California (February-March). Moisture conservation was obtained by each mulch material, with a minimal width of 6 inches generally required for significance over the nonmulched control. Bands of 24 inches were in turn superior to 6-inch widths. Interactions between width X sampling interval and width X depth were highly significant. Soil moisture retention was discussed in relation to soil temperature and crop response as influenced by width of mulching materials.

U. Calif., Riverside, Calif., 92502

211. Awan, A. B. INFLUENCE OF MULCH ON SOIL MOISTURE, SOIL TEMPERATURE AND YIELD OF POTATOES. Amer. Potato J. 41(10): 337-339. 1964.

The results of these experiments strongly indicated that in the tropics, where the soil temperatures are above the optimum for potato cultivation, a decrease in soil temperature from mulching caused significant increases in potato yields. Mulching also helped in the conservation of soil moisture.

Escuela Agricola Panamericana, El Zamorano, Honduras.

212. Northmore, J. M. SISAL WASTE—MULCH. Kenya Coffee 28(330): 201, 203, 206. 1963

Mulching of coffee in Kenya has been an established practice for many years, and its value in terms of increased yields has often been demonstrated. Most reported field experiments, however, have been concerned with grass mulches, such as Napier or Elephant grass, although several other materials have been used by planters where these materials have been readily available. Among the more widely used of these is sisal waste, the residue from the fleshy sisal leaf after mechanical extraction of the fibre. Sisal waste is readily available in large quantities in areas where sisal and coffee grow in close proximity and transport costs are low. Beneficial results have often been obtained from mulching with sisal waste, but care must be exercised in its use; indiscriminate mulching without due attention to the soil conditions of the area being mulched can lead to harmful results.

Sisal will extract relatively large amounts of calcium from a soil high in calcium. Such soils occur in many of the sisal growing areas of Kenya. The calcium remains in the sisal waste after the fiber is extracted and is then returned to the soil when the waste is used for mulching.

Analyses of sisal waste vary, particularly in moisture content. Relatively dry waste is cheaper to transport. The average moisture content was assumed to be 5 to 6 percent. A typical analysis on this basis is given in the following table.

Analysis of Sisal Waste

% Moisture	% Nitrogen	% Calcium	% Phosphorus
5.9	1.37	4.5	0.23

When sisal waste is applied to coffee at a rate of 10 tons an acre, it may be calculated that this is roughly equivalent to the application of 1 ton of lime (as $CaCO_3$) per acre.

A recent investigation carried out by the Sisal Research Station showed that a heavy application of sisal waste of analysis roughtly equivalent to the above, raised a topsoil pH from 4.8 to 6.5 after 2-1/2 years.

Coffee grows best on acid to medium-acid soils (pH 5.5 to pH 6.5). Soils which had been continuously mulched with large amounts of sisal waste for about 10 years were found to have an average pH of 8.0 and severe iron deficiency symptoms.

Iron deficiency is widely recognised as one of the most difficult deficiencies to cure. Spraying with iron salts of one kind or another is usually unsatisfactory, either because the condition is only temporarily alleviated or because the particular iron salt (chelate) is too expensive. Injection of trees has been advocated but is usually impractical.

It should not be inferred that sisal waste is to be rigidly rejected for use as a mulching material on coffee. With the right soil and under the right conditions it can be a very valuable material. Soils should be analysed beforehand to ascertain if the results are likely to be beneficial, with further soil analyses undertaken before each subsequent application.

Coffee Res. Sta.

PLANT MANAGEMENT

Pasture and Haylands

SEE ALSO 23, 43, 44, 51, 91, 110, 112, 114, 115, 121, 122, 136, 142, 143, 151, 157, 158, 160, 163, 166, 170, 173, 178, 181, 206, 212, 254.

213. Klapp, E. FEATURES OF A GRASSLAND THEORY. J. Range Mangt. 17(6): 309-322. 1964.

For an unbiased consideration of permanent grassland in research and teaching, clear understanding of the differences between cropping and grassland management is necessary. The raw material of cropping is the soil; its tool, soil preparation in the widest meaning; its aim, the uninterrupted growth of the single plant species. The raw material of grassland management is the grass sward, making unnecessary any soil preparation. The most important tool is the kind of utilization; its aim, the development of a productive plant community. Common features for both kinds of land use are found particularly in fertilization.

The decisive character of the grass sward as a species association does not diminish the importance of the single species. Its behavior as a single crop without the competition of other species admits nothing or only uncertain conclusions concerning its behavior in the dense grass sward. The difficulty and the length of experiments with mixed seedings make vegetation ecology indispensable.

The main point of influence of the grassland treatment is the competitive ability of the species. Within the plant association at any one site, a labile equilibrium of competitive abilities develops under homogeneous conditions. Any change of the environmental conditions including those affected by man and animal may shift this equilibrium at least in the mass proportion. The increase of the competitive ability of one species means mostly a reduction of another.

Among management procedures, changes in fertilization may effect considerable changes in the competitive ability. Influences of the kind of utilization upon the regeneration of plants, particularly upon the storage of reserve material, are still more effective. Grazing and mowing as management procedures moreover have a more or less controversial effect. This is similarly true for fertilization. That opens the possibility of equalizing undesirable consequences of one management procedure with the application of another.

Any change of the environment of biotic or abiotic nature earlier or later affects selection in the plant community. Working method and aim of the sward treatment affect the direction of selection in such a way, that the competitive ability of the desirable species is increased and that of the desirable ones is decreased. The possibilities are greater on sites which permit the use of mowing and grazing at any time. On the hay pasture, all improvement and management procedures are largely identical with utilization procedures, i.e. with harvesting techniques. Special procedures which are the rule in cropping become indispensable only if grazing is impossible.

In total, a grassland theory may subsist upon very few working hypotheses and theories. Its foundation is the behavior of the grassland plants within the species association.

Bibliography.

Inst. für Pfanzenbau, University Bonn, Germany.

214. Goss, J. R., Kepner, R. A., and Jones, L. G. HAY HARVESTING WITH SELF-PROPELLED WINDROWER COMPARED WITH MOWING AND RAKING. Trans. ASAE 7(4): 357-361. 1964.

In field drying-rate tests at Davis, Calif., total curing times down to an early morning moisture content of 20 percent were about 20 percent less for windrowed-and-conditioned alfalfa hay than for windrowed or mowed hay that had not been conditioned. The time of raking pairs of windrower windrows together (2 or 4 days after cutting) did not affect the total curing time provided there was at least one day between raking and baling.

Hay remaining in the windrower windrows consistently had a higher early-morning moisture content than the raked double windrows and was a little drier than the double windrows by evening. If there is insufficient dew during the curing period to permit raking without excessive load loss, windrowed hay can be baled without raking and the greater nighttime moisture pickup of the windrower windrows would be advantageous. But with normal or heavy dew, leaving the hay in the windrower windrows probably would delay baling.

Yields from windrowing and from mowing and raking were compared for a total of 12 cuttings in four alfalfa fields, all of which had irrigation levees. Only in one cutting of one field, where the hay was badly lodged, was the windrowed yield significantly greater than the mowed yield (6-percent difference). In a field with high irrigation levees only 28 ft. apart, windrowed yields in three successive cuttings were 9 to 13 percent less than mowed yields.

In two fields where the levees were 38 ft. and 60 ft. apart, windrowed yield for five cuttings in which there was little or no lodging averaged 2 to 7 percent less than mowed yields. These results indicate that under reasonably good mowing and raking conditions there should be little or no difference between windrowed and mowed yields in a flat alfalfa field that has no levees.

Windrowed hay tended to have a slightly higher protein content and lower crude fiber content than mowed hay, primarily because of the longer, low-quality stubble left by the windrower adjacent to the levees. There were no significant differences in either protein content or crude fiber content between windrowed-and-conditioned hay and windrowed hay that had not been conditioned.

Calculated costs per acre in relation to annual use, based on estimated cost factors and typical operating conditions, were included for six combinations of cutting, conditioning, and windrowing or raking operations.

U. Calif., Davis, Calif., 95616

215. Cummins, D. G., Newton, J. P., and Craigmiles, J. P. EFFECT OF SEEDING DATE ON SEASONAL PRODUCTION AND QUALITY OF TEMPORARY WINTER GRAZING CROPS. Crop Sci. 4 (6): 571-573. 1964.

An experiment was conducted over a 3-year period (1959-62) at Experiment, Ga., to study the effect of seeding dates and climatic conditions on the winter forage production of oats, wheat, and rye with and without ryegrass.

Seeding of oats, wheat, or rye alone or with ryegrass before September 1 resulted in a significant reduction in forage production. Rye produced more total forage than oats but not more than wheat. Adding ryegrass did not increase production, but extended the grazing season.

Planting on September 1, 2 weeks before recommended planting date of September 15, increased fall forage production without decreasing total production. Moisture was better in early fall and the hazard of stand failure was minimized by taking advantage of this better moisture condition for seed germination and plant establishment. Factors related to high temperature which occurred before September 1, prevented optimum yields.

Ga. Expt. Sta., Experiment, Ga.

216. Wilkinson, S. R., and Gross, C. F. COMPETITION FOR LIGHT, SOIL MOISTURE AND NUTRIENTS DURING LADINO CLOVER ESTABLISHMENT IN ORCHARDGRASS SOD. Agron. J. 56(4): 389-392. 1964.

The effects of root and shoot competition of orchardgrass, at four soil moisture levels, on the ability of ladino clover seedlings to become established in vigorous orchardgrass sods were investigated in greenhouse pot cultures. The moisture treatments were: Irrigation to near field capacity when soil moisture tensions approached 15, 2, and 1 atm.; and continuous irrigation from a tensiometer 50 cm. above a free-water surface.

Soil fertility levels were high and, based on preliminary studies plus plant tissue analyses for eleven mineral nutrients, mineral nutrient absorption was considered to be nonlimiting for establishment and growth of the ladino clover seedlings in this orchardgrass sod.

Root competition with orchardgrass tended to reduce the percent K in ladino clover seedlings. However, the percent K of ladino clover grown in root competition with orchardgrass was well above deficiency levels. Root competition of P significantly influenced P contents of ladino clover seedlings. Increasing soil moisture levels enhanced the P content of both ladino clover and orchardgrass.

Ladino clover seedlings were readily established in N-fertilized orchardgrass sods when favorable conditions of light, moisture, and nutrients were maintained. Fair establishment occurred under full root and shoot competition with N-fertilized orchardgrass when very high soil moisture and nutrient levels were maintained. The growth of ladino clover seedlings under conditions of full competition and no shoot competition at very high soil moisture was approximately one-half that of plants growing on similar soil surface areas in monoculture. Seedling growth suppression was observed early, and was present throughout the growth period.

SWCRD, ARS, USDA, Watkinsville, Ga., 30677

217. Dexter, S. T. ALTERNATE THREE-CUTTING SYSTEMS FOR ALFALFA. Agron. J. 56(4): 386-388. 1964.

A system of cutting alfalfa in areas with a growing season scarcely long enough for three-bed-cuts before September 1 was examined, in an attempt to make provision for inevitable delays in harvesting the first crop and for mid-summer retardation of growth due to drought. This system involved taking the first cutting in early bloom (about June 15) and delaying the second cutting until early August. The third cutting was taken about November 1 when a heavy freeze occurred or was likely and regrowth was unlikely. Over a period of years, with several sets of plots, this alternate system of taking 3 cuts of alfalfa resulted in yields of hay as good as those from the traditional 3 cuts before September 1 and somewhat reduced winter injury, particularly on sites where there was some danger of injury. Cutting only twice in the bloom stage still further favored longevity.

Agr. Expt. Sta., Mich. State U., East Lansing, Mich., 48823

218. Bruhn, H. D. MODERN METHODS OF HARVESTING AND CURING FORAGE. 6th Internatl. Cong. Agr. Engin. Trans. III: 933-941. 1964.

Forage harvesting methods in the north central area of the United States are accepted on the basis of adaptability to mechanization, quality of feed produced primarily for dairy cattle, availability of storage structures, and the ease with which the removal and feeding of the stored forage can be mechanized.

Legume and grass crops make up a major portion of the forage fed to dairy cattle in this region. Most is stored as field cured, dry hay, and grass silage.

From the initial grass silage which was put into storage at essentially the moisture content of the standing crop in the field, the moisture content at the time of storage has been gradually reduced to only slightly higher than dry hay. Lower moisture content of grass silage at the time of storage has: Eliminated the necessity of adding preservatives; stimulated fermentation; developed less undesirable odors; and increased the dry matter intake of the animals.

In both the production of dry hay and low moisture silage, the forage crusher is an aid to producing quality feed. It aids in rapid harvest, reduces possible weather damage, leaf loss, and bleaching.

The effectiveness of a forage crusher depends on construction features, pressure on the crushing rolls, and thickness of the mat of material passing through the rolls. Improper operation reduces its effectiveness and may nulify its value.

Modified flail-type forage choppers accelerate forage drying rates at the expense of excessive leaf loss.

The forage crusher in conjunction with a mower is an aid in the making of high quality, low moisture grass silage. In the humid climate, the use of large self-propelled windrowers in making low moisture grass silage is of questionable value. The use of a combination self-propelled windrower and crusher is a modest improvement on the windrower alone.

U. Wis., Madison, Wis., 53706

219. Paterson, J. J., Benson, H. F., Browning, D. R., and Portz, H. L. FIVE YEARS OF HAYMAKING EXPERIENCE WITH A FLAIR FORAGE HARVESTER. 6th Internatl. Cong. Agr. Engin. Trans. III: 1005-1018. 1964.

Conventional hay harvesting methods in the Corn Belt consist of mowing, raking into windrows, and baling. With increasing emphasis on quality, a minimum of exposure to weather is essential.

The hay crusher or crimper immediately following the mower reduces this exposure time from one-third to one-half. This requires three machines and two field operations before baling at 20-25 percent moisture. In good weather, the entire operation may be completed in 2 days.

Hay cut into a swath with a cylinder flail forage harvester has been known to dry enough to bale the same day under ideal conditions. Only one multipurpose machine and one operation is needed to cut, condition, and windrow for baling, instead of the three machines and two operations now required for the hay crusher.

Over a period of 5 years, ten comparisons were made between the generally accepted mower-crusher method and the cylinder flail harvester. In seven of these, the conventional mower without conditioner and the common rotary mower with windrowing attachment were included in the comparisons.

Replicated plots cut at the same time were raked or turned as necessary, then baled. Hay samples for moisture tests were taken every 2 to 3 hours during the day and variations analyzed graphically. Weather data were recorded. Samples of one hundred grams were carefully separated according to stem length, which gave an indication of losses to be expected in handling. Hay cut by the three methods: Mowed and crushed; cylinder flail; and rotary flail harvesters was fed to dairy cows to obtain a comparison of acceptability.

Under typical haying conditions in Southern Illinois the following results were obtained using the accepted mower-crusher method of cutting as a basis of comparison:

1. Mowed-crushed hay dried faster than hay mowed only, in all trials.
2. Mowed-crushed hay dried significantly faster than cylinder flailed hay in seven out of ten comparisons.
3. Mowed-crushed hay dried significantly faster than rotary flail cut hay in all trials.
4. Rotary flail cut hay dried slightly faster than cylinder flail cut hay in six out of seven comparisons.
5. Rotary flail cut hay was slightly slower drying than hay mowed only in three out of four comparisons.
6. In feeding trials with dairy cows, hay cut by the conventional mower crusher was consumed at over twice the rate of either the cylinder flail or rotary flail cut hay.
7. Stem length comparions showed a large proportion of long stems in mowed and crushed hay, and a very small proportion in cylinder flail cut hay.

Southern Ill. U., Carbondale, Ill.

220. Curley, R. G., and Dobie, J. B. WAFERED-HAY HANDLING SYSTEM. Trans. ASAE 7(3): 326-328. 1964.

Commercial experience with hay wafers was studied to answer some of the questions on handling and feeding hay in this form. The authors concluded that:

1. Wafers with the proper physical characteristics were satisfactorily bulk handled, utilizing mechanical equipment to save labor. At the same time, storage space requirements were only one-third to one-half that of baled hay.

2. Improvements in handling methods and equipment will be made as more experience is gained. Wafer damage and the production of fines occurred each time there was a transfer such as the loading or unloading of a truck or bin. The number of transfers should be held to a minimum and equipment and methods which will produce a minimum of wafer damage should be used.
3. Product acceptance has been excellent. Dairymen like the wafers both from a feeding handling point of view. Truckers also like the idea of eliminating bale handling and the labor problems associated with it.
4. Unless the moisture content of the wafers can be held below about 15 percent, it may be necessary to provide aeration facilities in storage.

U. Calif., Davis, Calif., 95616

221. Dobie, J. B. MECHANIZED FEEDING OF WAFERED HAY. 6th. Internatl. Cong. Agr. Engin. II: 534-541. 1964.

The demand by dairymen for wafered hay has exceeded the supply. Animal acceptance and performance has been good, compared to baled hay as evidenced by a 10 to 15 percent increase in feed intake and a corresponding increase in milk production. Wafered hay contains sufficient roughage to maintain butterfat production by dairy cows, and also provides the free-flow characteristics needed for bulk handling and mechanized feeding.

Three types of systems are used in feeding wafered hay. The gravity-feeding system is least expensive but lacks daily control of the amount fed and permits some selectivity by animals. Conveyor-feeding and wagon-feeding require more equipment and labor, but provide better control of the amount fed and reduce the chance for selection by animals.

Wafered hay costs the dairyman $5 per ton more than baled hay. Most of the higher feed cost is offset by direct savings from reduced storage cost, reduced feeding cost, less waste of feed, reduced consumption of concentrate feed, and increased hay consumption and milk production. Personal satisfaction and improved employee relations, due mainly to elimination of drudge labor, help make wafered hay worth the added cost to the dairymen who have used it.

U. Calif., Davis, Calif., 95616

222. Halls, L. K., Hughes, R. H., Rummell, R. S., and Southwell, B. L. FORAGE AND CATTLE MANAGEMENT IN LONGLEAF-SLASH PINE FORESTS. U.S. Dept. Agr. Farmers B. 2199, 25 pp. 1964.

Recommendations for forage and cattle management in longleaf-slash pine forests were summarized as follows:

1. The rancher should learn to recognize the main forage plants on the range. Grasses, such as slender, pinehill, and creeping bluestem, pineland threeawn, and Curtiss dropseed, are most prevalent; but other grasses, forbs, and evergreen browse are important in adding variety to the cattle diet.
2. The range should be grazed moderately to get the best balance between cattle gains per acre and per head.
3. All forest uses should be considered fully before making prescribed burns. Generally fires should be excluded until trees are at least 8 to 10 feet tall. Thereafter they can be prescribe-burned at 2- to 5-year intervals to improve forage, remove litter, reduce wildfire hazard, and control undesirable plants.

4. Trees should be thinned regularly, first when they average 6 inches in diameter breast high and thereafter at about 5-year intervals.
5. Grazing damage to pine seedlings can be avoided by one or a combination of ways: Graze the range lightly to moderately exclude cattle from range during fall and winter; and exclude cattle year round until young trees are at least 3 feet tall.
6. To provide yearlong forage, improved pastures should be developed to supplement forest range. Pasture grasses should be cut in spring and early summer and stored as hay to be fed in winter; 1 to 1.5 tons per cow. The possibilities of establishing improved pastures as fire-break strips through the forest should be considered.
7. Sawpalmetto and gallberry should be controlled with prescribed burning. Noncommercial hardwoods should be killed with 2,4,5-T applied in frills, girdles, or by tree injector.
8. The lands to be grazed should be fenced. For leased lands, have a written agreement.
9. The following feed supplements should be used: 375 pounds per cow of cottonseed cake or meal (crude protein) in fall and winter; steamed bonemeal (phosphorus and calcium) and salt free-choice yearlong; and iron, cobalt, and copper all year in south and central Florida.
10. Some Brahman blood should be maintained in dams. These should be bred to tested bulls of British breeds. Bulls should be rotated or replaced every 3 to 4 years.
11. The breeding season should be restricted to about 3 months so that calves born in winter can take advantage of good forage and the cows' maximum milk flow in spring.
12. Calves should be weaned and marketed in late summer.
13. Cows that fail to raise a 400-pound calf 3 years out of 4 should be culled. Replacements from high-producing dams should be selected.
14. Heifer calves should be vaccinated against Bang's disease if they are to go into the breeding herd. Hornflies should be controlled.
15. A practical balance should be maintained among cattle, forage, and trees.

Tables and photographs.

FS, USDA, Inform. Div., Washington, D.C., 20250

223. Mazzoni, L. E., and Scholl, J. M. EFFECT OF CHEMICAL AND MECHANICAL WEED CONTROL IN SPRING-SEEDED LEGUMES ON ESTABLISHMENT OF INTERSEEDED GRASSES. Agron. J. 56(4): 403-405. 1964.

A study to compare the effectiveness of dalapon, 4-(2,4-DB), dalapon plus 4-(2,4-DB), and mowing on July 8 or August 1 for weed control in new legume seedings was conducted at Arlington, Wis., in 1960-61. These treatments were applied to alfalfa and birdsfoot trefoil seeded without a companion crop. Orchardgrass and bromegrass were inter-seeded in subplots on Aug. 1, Aug. 15, Sept. 1, or Sept. 15 to determine the possibility of subsequently introducing grasses into legume seedings established with dalapon.

Yields of legumes in the year of seeding were higher for the combination of dalapon and 4-(2,4-DB) than from the chemicals applied alone or from mowing on July 8 or August 1. Broadleaf weeds were more abundant than grassy weeds and, consequently, 4-(2,4-DB) was more effective than dalapon.

The data suggest that bromegrass may be subsequently established in alfalfa seeded in spring with the aid of dalapon and 4-(2,4-DB). This procedure appears to be unsatisfactory for orchardgrass which does not establish well from summer seedings nor for birdsfoot trefoil which is damaged by close mowing at the time of direct seeding of the grass.

Jr. Author, Agr. Expt. Sta., U. Wis., Madison, Wis., 53706

224. Peters, E. J. PRE-EMERGENCE, PREPLANTING AND POSTEMERGENCE HERBICIDES FOR ALFALFA AND BIRDSFOOT TREFOIL. Agron. J. 56(4): 415-419. 1964.

Several preemergence, preplanting, and postemergence herbicides were evaluated alone and in combinations for controlling weeds in seedling alfalfa and birdsfoot trefoil. The following conclusions were drawn:

1. With good weed control, high fertility, and adequate moisture, up to 3 tons of hay was obtained during the seedling year from alfalfa sown in April.
2. Average hay yeilds were about 1,000 pounds per year greater on plots where weeds were controlled than on the check.
3. Herbicides reduced weeds and increased legume yields especially in the first cutting.
4. In years when weather was favorable for alfalfa growth, yields of second or third cuttings were not appreciably affected by weed control. In dry seasons, large numbers of weeds in the early part of the season reduced available moisture so that yields of alfalfa were reduced in the late cuttings.
5. Herbicides improved quality by reducing weed content of the hay.
6. Neburon was more effective in years of adequate rainfall than in dry years.
7. Neburon was equal to 4-(2,4-DB) for controlling broadleaved weeds when moisture was adequate but inferior to 4-(2,4-DB) in dry years.
8. EPTC often did not control broadleaved weeds as well as neburon or 4-(2,4-DB), but EPTC was superior to neburon and 4-(2,4-DB) for weed-grass control.
9. Dalapon applied postemergence with 4-(2,4-DB) may be intercepted by broadleaved weeds and alfalfa and cause poor control of weed grasses.
10. Dalapon applied immediately after the first cutting controlled weed grasses but injured alfalfa to some extent.
11. Granular EPTC generally controlled weeds to about the same degree as liquid EPTC.

CRD, ARS, USDA, Columbia, Mo.

225. Buckman, R. E. EFFECTS OF PRESCRIBED BURNING ON HAZEL IN MINNESOTA. Ecology 45(3): 626-629. 1964.

Single or repeated spring prescribed fires and single summer fires easily killed aerial stems of hazel (Corylus spp.). Although vigorous and abundant resprouting followed spring fires, resprouting was less vigorous after summer fires. Repeated summer fires destroyed the ability of hazel to resprout by: (1) Exposing and destroying underground stem systems; and (2) probably exhausting stored food reserves. A single fire eliminated hazel where humus was sufficiently dry to be completely consumed. This drying sometimes occurred in the summer or fall, but rarely if ever in the spring.

Lake State Forest Expt. Sta., FS, USDA, St. Paul, Minn., 55101

SEE ALSO 11, 23, 115, 119, 163, 201, 222.

226. Rauzi, F. LIGHT VS. MODERATE GRAZING SHOWS MODERATE BEST ON SHORTGRASS. Wyo. Stockman-Farmer 70(4): 32. Apr. 1964.

Results of long-term research at Archer agricultural substation in Wyoming favored moderate over light grazing on shortgrass rangeland. Duplicate pastures have been lightly and moderately grazed since 1945 by sheep. During a 17-year period (1947-63) moderately grazed pastures averaged 46 sheep days of grazing per acre while those grazed lightly averaged 30 sheep days per acre.

Average lamb gain per acre from moderately grazed pastures during 19 years (1945-63) was 27.6 lb. and from lightly grazed pastures, 17.2 lb.

Herbage production was affected by the following: Kind of grazing animal (sheep, cattle, and/or game animals); past use; available moisture; and dominance and growth characteristics of perennial grasses, weeds, and forbs.

At Archer, perennial grass yields from 1947-63 averaged 513 lb./A. from moderately grazed pastures and 612 lb./A. from lightly grazed pastures.

SWCRD, ARS, USDA, Laramie, Wyo., 82071

227. Cable, D. R., and Martin, S. C. FORAGE PRODUCTION AND STOCKING RATES ON SOUTHERN ARIZONA RANGES CAN BE IMPROVED. U.S. Forest Res. Note RM-30, 11 pp. 1964.

Herbage production of annual and perennial grasses, basal intercept of perennial grasses, and stocking rates have been measured since 1954 on four range units of the Santa Rita Experimental Range, Ariz., primarily to determine the reaction to mesquite control. Mesquites were killed on two of the united between 1954-57 by spraying diesel oil on the lower truck of each tree.

The changes in vegetation measured during the 8-year period were caused by three main factors: Year-to-year variation in precipitation; management practices; and mesquite control.

The native annual and perennial grasses on these range units are preimarily summer growers, and thus depend for their growth primarily on summer rainfall. The correlation between June-September rainfall and perennial grass herbage production was significant, but explained only about 39 percent of the year-to-year variation in production. Annual grass production, on the other hand, was more closely correlated with rainfall; over half of the year-to-year variation in production was explained by variations in June-September rainfall.

Moderate utilization of the perennial grasses combined with alternate-summer deferment of grazing resulted in marked range improvement. On the average, production of perennial grasses increased by more than 4 pounds per acre per inch of summer rainfall per year, from about 19 lb./A./in. of summer rainfall in 1954 to about 45 pounds in 1961.

Perennial grass production on the mesquite-killed range units increased relative to the two untreated units between 1957 and 1961. The increase amounted to a net gain of 443 lb./A. on the mesquite-killed units compared to 220 lb./A. on the mesquite-alive units.

Annual grass production was more markedly affected by mesquite density than was perennial grass production. Annual grass production decreased nonlinearly from 20 lb./A./in. of summer rainfall with 0.25 percent mesquite crown intercept to 5 pounds with 7 percent crown intercept.

Calculations of stocking rates that would have given 40 percent use of perennial grasses for each unit and year showed that the stocking rates on the two mesquite-killed units have increased an average of 169 percent between 1954 and 1961, compared to an increase of 62 percent on the two mesquite-alive units.

Rocky Mountain Forest and Range Expt. Sta., FS, USDA, Fort Collins, Colo., 80521

228. Penfound, W. T. THE RELATION OF GRAZING TO PLANT SUCCESSION IN THE TALL GRASS PRAIRIE. J. Range Mangt. 17(5): 256-260. 1964.

The effects of complete protection from grazing upon plant composition and plant succession in tall grass prairie and revegetating cropland were reported. These grassland plots, located about 10 miles southwest of Norman, Okla., have been protected from grazing since 1949. They were designated as follows: Protected prairie; grazed prarie; protected cropland; and grazed cropland. In all plots, autumn composition was determined by means of 25 quadrats of 0.1 sq. m. each.

In the protected prairie, the vegetation changed from midgrass (1950) through representative tall grass prairie (1959) to tall grass prairie with many woody species (1962). If protection continues, it seems probable that much of the protected prairie will be taken over by woody plants. In the grazed prairie, the vegetation remained nearly constant since the midgrass (little bluestem) was the major dominant throughout.

In the protected cropland, the vegetation changed rapidly through the following stages: Annual (1950; forb-short grass (1954), to short grass-midgrass-tall grass (1962). In the grazed cropland the plant population shifted from annual grass (1950), short grass-midgrass (1959), to a midgrass type (1962).

The most important species in all four tracts was the little bluestem. Considerable plant succession occurred in all plots but was much more rapid in the protected units.

U. Okla., Norman, Okla.

229. Hickey, W. C., Jr., and Garcia, G. RANGE UTILIZATION PATTERNS AS AFFECTED BY FENCING AND CLASS OF LIVESTOCK. U.S. Forest Serv. Res. Note RM-21, 7 pp. 1964.

The effects of fencing small watersheds and stocking them with different classes of cattle on the grazing patterns were studied.

The San Luis experimental site in New Mexico, consists of three adjacent watersheds (529, 525, and 364 acres) in the transition zone between woodland and semi-desert grassland. Principal forage species are alkali sacaton (Sporobolus airoides Torr.) and galleta (Hilaria jamesii (Torr.) Benth.). Average annual precipitation is 13 in.

Three distinct topographic types exist on the watersheds—"uplands" "breaks", and "alluvium". The high, rocky hills of the "uplands", or headwaters, terminate in rocky "breaks", from which steep hillsides extend down to the gently sloping "alluvial" grassland.

The three watersheds were grazed from October to May each year (winter grazing) by various classes of Hereford cattle. The author concluded that:

1. Utilization patterns on small watersheds grazed by yearling cattle were about the same before and after fencing.
2. Yearling cattle utilized grasses more uniformly over variable terrain than did either cows with calves or mixed classes of cattle.
3. Yearling heifers were more active than yearling steers on steep, rocky terrain.
4. Cows and calves tended to utilize alkali sacaton and galleta immediately surrounding water much more heavily than did yearlings.

5. Old cows with calves tended to utilize the sheltered areas predominantly, and entered open terrain only when forced out due to lack of forage.
6. Young cows with calves used the open grasslands more than old cows, and entered the edges of the more inaccessible terrain only when faced with a lack of forage.
7. On rough terrain, more uniform utilization was attained by grazing with yearling heifers. When grazed as open range, mixed classes gave most uniform use.

Rocky Mountain Forest and Range Expt. Sta., FS, USDA, Albuquerque, N. Mex.

230. Springfield, H. W. SOME FACTORS AFFECTING GERMINATION OF FOURWING SALTBUSH. U.S. Forest Serv. Res. Note RM-25, 8 pp. 1964.

Fourwing saltbush (Atriplex canescens) is one of the most valuable browse plants on Southwestern ranges. Studies of native stands indicate this species grows under a wide variety of environmental conditions, withstands drought, heat, and cold, and provides palatable, nutritious forage the year round for both game and livestock.

Preliminary information was presented on the effects of differences in source of seed, treatment of seed, and temperatures on germination of fourwing saltbush seed in the laboratory. Several of the findings appear to have application value for range seedings.

Germination of fourwing saltbush varied with source of seed. In a comparison of eight sources, seed collected at Isleta, N. Mex., showed significantly higher germination than seed from other sources. The embryos in seeds from some sources exhibited a greater dormancy than seed from others.

Removing the wings from the seed did not improve the total germination of fourwing saltbush. The de-winged seed, however, germinated more quickly than the winged seed. This faster germination is desirable because the right combination of temperature and soil moisture is of short duration in many range areas. Other advantages of de-winging the seed are: (1) Ease of handling, especially when the seed is to be drilled; (2) reduction in bulk; and (3) easier coverage with soil.

Temperature strongly influenced germination of fourwing saltbush. Germination of seed from all eight sources was higher at temperatures from 42° to 58° F. than at temperatures of 73° to 77° F. Although the summer months appear unfavorable from the standpoint of temperatures, these months are best when considering dependability and amount of precipitation in the Southwest. Because of the apparent conflict between temperature and moisture factors, further research is needed on the subject.

Rocky Mountain Forest and Range Expt. Sta., FS, USDA, Fort Collins, Colo., 80521

231. Hyder, D. N., and Bement, R. E. SIXWEEKS FESCUE AS A DETERRENT TO BLUE GRAMA UTILIZATION. J. Range Mangt. 17(5): 261-264. 1964.

Sixweeks fescue was evaluated as a deterrent to the utilization of blue grama by observing cattle preferences for plots untreated, fertilized with ammonium nitrate at 40 lb. N./A., and treated with simazine. Nitrogen increased sixweeks fescue and samazine killed it. Mean preferences were 20, 40, and 40 percent for untreated, nitrogen, and simazine plots, respectively, but preferences changed as the season progressed. Samazine plots were always highly preferred. Nitrogen plots were preferred less than untreated ones in early May when blue grama growth was just beginning and equal to or more than simazine plots at later dates. Preferences for untreated plots decreased from 30 percent in May to 12 percent in September, indicating a seasonal gain in the deterrence associated with sixweeks fescue. Sixweeks fescue was unacceptable to cattle at all seasons, and nitrogen failed to increase its rooting strength or palatability. Yearling Hereford heifers rejected sixweeks fescue by staying away from infested plots, or by grazing carefully around the plants encountered.

Sixweeks fescue was most abundant on the "plains upland" range site, which is very extensive on the Central Great Plains. Range units on this site grazed at intensities of none, light, moderate, and heavy since 1939 all had high frequencies of sixweeks fescue in 1962. Therefore, this weed will not be controlled by reducing stocking rates. Fluctuating weather conditions will continue to produce sharp changes in fescue abundance unless cultural control practices are introduced. Several herbicides should be compared in terms of effectiveness, cost, and chemical residues to find one that can be approved for practical applications on blue grama range.

CRD, ARS, USDA, Fort Collins, Colo., 80521

232. Kay, B. L. PARAQUAT FOR SELECTIVE CONTROL OF RANGE WEEDS. Weeds 12(3): 192-193. 1964.

Paraquat removed weedy annual grasses from seedings of rose clover (Trifolium hirtum All.) and subclover (T. subterraneum L.) with only temporary damage to the clovers when applied at early growth stages. Paraquat applied under weed-free condi tions reduced herbage yields of Lana woollypod vetch (Vicia dasycarpa Ten.) and Wimmera ryegrass (Lolium rigidum Gaud.) at three dates of application; either herbage nor seed yields of rose or subclover was reduced.

U. Calif., Davis, Calif., 95616

233. Cronin, E. H., and Williams, M. C. CHEMICAL CONTROL OF TIMBER MILKVETCH AND EFFECTS ON ASSOCIATED VEGETATION. Weeds 12(3): 177-179. 1964.

Livestock losses, mainly to cattle, from timber milkvetch (Astragalus miser Dougl. ex Hook.) have been reported since 1927. The species is found in the northwestern United States and also in Alberta and British Columbia in Canada. Recent taxonomic treatment distinguished eight varieties. The most northern variety (A. miser var. serotinus (Gray) Barneby) and the most southern variety (A. miser var. oblongifolius (Rydb.) Cronq.) are the only two varieties know to cause livestock losses, but all varieties should be regarded as poisonous until it is known they are not. A. miser var. oblongifolius was controlled with 2 lb./A. of 2,4,5-T or silvex. Removal of A. miser increased both cover and frequency of grass species.

CRD, ARS, USDA, Logan, Utah.

234. Thatcher, A. P., Davis, G. V., and Alley, H. P. CHEMICAL CONTROL OF PLAINS PRICKLYPEAR IN SOUTHEASTERN WYOMING. J. Range Mangt. 17(4): 190-193. 1964.

Field trials to chemically control plains pricklypair were conducted near Douglas, Wyo., during the spring seasons of 1961-62. Results were recorded through three growing seasons. Silvex, 2,4,5-T, and 2,3,6, TBA were applied as sprays to plains pricklypear in various rates and with various kinds and amounts of carriers during the spring of 1961. Half of each plot was mechanically treated with a cultipacker so as to puncture or injure the pricklypear plant just prior to applying the herbicides. Silvex was generally superior to the other herbicides. In 1962, 2 and 4 pounds of silvex were applied to mechanically treated acre-size plots. The results of these two trials were summarized as follows:

1. Silvex proved to be superior to 2,3,6 TBA and 2,4,5-T when applied at 2 and 4 lb./A. These rates proved effective in controlling plains pricklypear and did not injury any of the desirable range grasses. These rates also effectively controlled the big sagebrush.
2. Prior mechanical injury of pricklypear plants greatly increased the effectiveness of all the herbicides except those applied at the 10 and 12 pound rates.
3. Mechanical injury alone contributed approximately 25 to 30 percent of the control.
4. 2,3,6 TBA damaged or killed most of the desirable range plants at all rates. The high rates of silvex and 2,4,5-T also damaged some of the desirable forage plants.
5. Approximately 15 percent of the plains pricklypear control resulted from insect damage and other natural causes.
6. The estimated cost of applying 2 and 4 pounds rates of silvex was $8 to $14 per acre respectively which included cost of mechanical injury and application of chemical.

SCS, USDA, Torrington, Wyo.

235. Bovey, R. W. CONTROL OF YUCCA BY AERIAL APPLICATION OF HERBICIDES. J. Range Mangt. 17(4): 194-196. 1964.

Preliminary studies of yucca control by aircraft applications in western Nebraska revealed that silvex applied at 2 lb./A. in No. 2 diesel oil at 5 g.p.a. total spray solution gave the best yucca kill from a single application of all herbicides, carriers, and spray volumes used. A substantial amount of yucca regrowth was found in all plots 2 years following treatment indicating retreatment was necessary for best control.

In June 1960, studies were conducted to determine the most economical and effective silvex rates to use in combination with No. 2 diesel oil. Results revealed that 2 lb./A. of silvex gave as much yucca kill as 4 lb./A. Repeat applications 1 year after initial treatment did not improve control. Some yucca regrowth occurred in all plots. Total regrowth was considered small and lacked regenerative vigor as indicated in counts taken 1, 2, and 3 years after treatment.

In a herbicide carrier-spray volume study established in June 1961, no differences were found in yucca kill between 2 and 5 g.p.a. spray volume treatments. No. 2 diesel oil applied as the silvex carrier tended to produce the best yucca kills from a single application. Repeated applications of identical treatments did increase kill.

CRD, ARS, USDA, College Station, Tex., 77841

236. Hughes, E. E., and Darrow, R. A. HERBAGE PRODUCTION RESPONSES TO PELLETED FENURON AND GRANULAR 2,3,6-TBA. J. Range Mangt. 17(4): 197-199. 1964.

Two herbicides, pelleted fenuron and granular 2,3,6-TBA, were hand-broadcast on prairie upland, shallow upland, and bottomland sites to evaluate yield responses of native grasses.

Neither herbicide affected herbage production on the sandy upland site. Heavy rates of 2,3,6-TBA decreased production on both prairie upland and bottomland sites characterized by clay or clay-loam soils. A greater reduction resulted on the prairie upland site having a cool-season grass (Texas needlegrass). Fenuron also showed a trend toward reduced yields of the bottomland site.

No date of application reduced herbage application significantly on the sandy upland site, but there was a highly significant effect on the prairie upland site. February and April applications produced greater reductions than the December applications. The later applications also tended to give lower yields on the bottomland site.

CRD, ARS, USDA, Los Lunas, N. Mex.

237. Duvall, V. L., and Whitaker, L. B. ROTATION BURNING: A FORAGE MANAGEMENT SYSTEM FOR LONGLEAF PINE-BLUESTEM RANGES. J. Range Mangt. 17(6): 322-326. 1964.

Burning one-third of the range in winter or early spring in a 3-year rotation improved grazing on longleaf pine-bluestem ranges, both cutover and timbered.

In a 6-year test in central Louisiana, cattle obtained most of their forage from recently burned range. Utilization of herbage grown during seasons following fire averaged 78 percent. In the second and third years after fire, utilization averaged 31 and 18 percent. Intense grazing following fire reduced herbage production, but the 2 years of relatively light use apparently restored plant vigor. Herbage produced during the final year of rotation was essentially the same as on unburned, moderately grazed range.

Rotation burning generally improved range vegetation and grazing distribution. Fire top-killed scrub hardwood and minimized the proportion of cutover muhly, an unpalatable perennial. It also eliminated pine litter accumulations, which retared grass growth.

Cows grazing rotation-burned range generally gained during summer and fall, when forage values on unburned, moderately grazed range were usually too low to sustain body weight. Cows with calves gained 57 pounds per head from April to August weaning dates, and 77 pounds between August and November. During these periods dry cows gained 161 and 37 pounds per head. When combined with adequate winter supplementation, rotation burning permited efficient yearlong beef production on native forage.

Southern Forest Expt. Sta., FS, USDA, Alexandria, La.

238. Elwell, H. M. OAK BRUSH CONTROL IMPROVES GRAZING LANDS. Agron. J. 56(4): 411-415. 1964.

The low-volatile ester of 2,4,5-T at 2 pounds acid applied in 5 gallons of oil-water emulsion per acre during May 15 to July 15 has generally given good to excellent control of oaks and release of desirable native grasses. Retreatment 1 or 2 years later during June 15 to July 20 was usually essential for killing 70 percent or more of the oaks. The 2,4,5-T was slightly more effective than silvex on mixed stands of post, blackjack, chinquapin oaks, and associated species. Silvex has generally been slightly more effective on post oak. Oak control was erratic with 2,4-D.

Diesel oil alone as a diluent for esters of 2,4,5-T gave slightly more defoliation of oaks than emulsions of diesel oil in water. Drift from 2,4,5-T in diesel oil was greater than that of herbicide in oil in water emulsions.

Single-winged and bi-winged airplanes were equally effective in applying herbicide sprays. Sprays should be made on a flagged swath of 40 feet or less, at a uniform height above the brush, when wind velocity is 5 miles per hour or less, and during periods of relative high humidity and moderate air temperatures. The oak plants should be in full leaf and growing actively when treated.

The 2,4,5-T at 17 pounds and above in diesel oil or kerosene for a total volume of 100 gallons was effective for basal-bark, injector, and stump treatments. This treatment has effectively killed oak plants resistant to foliar spray. In rancher and farmer basal-bark and stump treatments, 2,4,5-T ester at 12 to 16 pounds in 100 gallons of diesel oil or kerosene has been satisfactory.

Good to excellent native grass release occurred when selective herbicide treatments effectively controlled oak brush. Deferring of grazing from May to October after a first spray treatment allowed native grasses to make maximum growth and increase stand density. Oaks in southeast Oklahoma aerially treated with 2,4,5-T and deferred for grazing 2 years produced 6,000 pounds grass per acre. The annual rainfall on the area was 42 inches. Adjacent untreated oak areas produced 400 to 600 pounds of grass per acre.

CRD, ARS, USDA, Stillwater, Okla., 74075

239. Pond, F. W. RESPONSE OF GRASSES, FORBS, AND HALFSHRUBS TO CHEMICAL CONTROL OF CHAPARRAL IN CENTRAL ARIZONA. J. Range Mangt. 17(4): 200-203. 1964.

Responses of grasses, forbs, and halfshrubs following chemical control of chaparral were observed from 1954-59 on the Sierra Ancha Experimental Forest, Ariz. Study areas were classified and results were presented according to dominant vegetation, aspect, and soil origin.

Soils derived from quartzite were shallow and contained considerable amounts of clay. Islands of grass were present in the chaparral before treatment. Following shrub control with herbicides, the cover of all understory vegetation on quartzite soil increased, but increase in grass cover was quicker and more spectacular. Halfshrubs and forbs increased less rapidly but continuously. Increase in grass production was also greater on this soil.

Soils derived from diabase were deep and sandy. They supported no islands of grass in the chaparral. Here, halfshrubs increased greatly in cover and production following control of overstory shrubs. Grasses showed little if any response, while forbs increased in cover somewhat more than on quartzite soils.

Rocky Mountain Forest and Range Expt. Sta., FS, USDA, Fort Collins, Colo., 80521

240. Bovey, R. W. AERIAL APPLICATION OF HERBICIDES FOR CONTROL OF SAND SAGEBRUSH. J. Range Mangt. 17(5): 253-256. 1964.

Single and repeat aerial applications of 2,4-D; 2,4,5-T; a 1:1 mixture of 2,4-D and 2,4,5-T; and silvex were applied for sand sagebrush control in western Nebraska. Single applications of phenoxy herbicides gave excellent control at some locations. Repeat applications were necessary for best results to kill regrowth the year following initial treatment with 2,4-D and/or 2,4,5-T. Silvex consistently gave excellent control from a single application at the rates used.

Silvex at 2 lb./A. and 2,4-D at 1 lb./A. were applied in combination with No. 2 diesel fuel, water, and water plus surfactant carriers. Spray volumes of 2 and 5 g. p.a. were used with all carrier combinations. There were no differences in sand sagebrush control due to carriers or spray volume.

CRD, ARS, USDA, College Station, Tex.

241. Dalrymple, R. L., Dwyer, D. D., and Santelmann, P. W. VEGETATIONAL RESPONSES FOLLOWING WINGED ELM AND OAT CONTROL IN OKLAHOMA. J. Range Mangt. 17(5): 249-253. 1964.

The effect was determined of brush control and reseeding on herbage production, percent species composition of grasses, and relative abundance of forbs and small-stemmed woody plants. A check and the following three treatments were applied in May, 1962: Natural recovery; native seeded; and King Ranch bluestem seeded. Trees were killed by 2,4,5-T injection on all treatments but the check.

A tree kill of 92 to 100 percent resulted in 2 to 3 times more total forage in the treated plots than the check the first year and as much as seven fold the second year. Most of the herbage yield was made up of less desirable grass and forb species. Basal cover of grasses increased from less than one percent initially to 2.0 to 2.8 percent the second year on the injector treated areas. Seeding of native grass did not contribute to yield or species composition until the second year. Seeded King Ranch bluestem made some contribution both years.

Big bluestem, little bluestem, Indiangrass, and King Ranch bluestem tended to increase in the species composition but were not dominant at any time. Grasslike plants decreased in percent composition. These changes showed the response of the various species to the altered environment. Generally, all forbs increased in the 2,4,5-T injection treatments after the treatment.

The results indicated that natural recovery of desirable grasses following brush control on this vegetative type was a slow process. This was especially true where few desirable species were present at the time of treatment. Reseeding offers an opportunity to speed up the establishment of forage species.

Okla. State U., Stillwater, Okla., 74075

242. McCorkle, C. O., Jr., Murphy, A. H., Rader, L., and Caton, D. D. COST OF TREE REMOVAL THROUGH CHEMICALS. J. Range Mangt. 17(5): 242-244. 1964.

Density of tree cover, a major determinant of forage production in woodland-grass ranges, can be changed by chemical treatment of individual trees. Labor and materials costs, the essential cost components, are determined by the quantity of labor and materials used and their prices. Labor and material requirements are functionally related to diameter of trees treated, density of stand, and species treated. Therefore, costs per acre to treat trees can be related to these same variables and, additionally, to the prevailing wage rates and cost of chemical material used.

Cost per acre for chemical tree treatment by species and diameters[1]

Diameter of trees treated	Total per acre cost of treatment: Blue oak	Black oak	Live oak	Madrone	Manzanita
	(Dollars)				
3	2.69	2.54	3.22	3.74	3.60
5	4.23	5.15	5.34	5.41	5.35
7	5.77	6.95	7.37	7.09	7.07
9	7.30	8.75	9.43	8.75	-
11	8.85	10.56	11.50	10.42	-

[1] These estimated costs are based on the following conditions: density of 120 trees per acre, labor at $1.50 per hour, and 2,4-D applied at a rate of 0.075 ounce per inch of tree diameter at a cost of $1.05 per pound.

U. Calif., Davis, Calif., 95616

Plant Materials

SEE 144, 230, 260, 284, 306.

Woodlands

SEE ALSO 11, 20, 21, 22, 26, 132, 133, 145, 152, 169, 222, 225, 238, 241, 242, 294, 305, 306.

243. Mueller-Dombois, D. EFFECT OF DEPTH TO WATER TABLE ON HEIGHT GROWTH OF TREE SEEDLINGS IN A GREENHOUSE. Forest Sci. 10(3): 306-316. 1964.

Seedlings of *Pinus banksiana*, *P. resinosa*, *Picea mariana*, and *P. glauca* were grown from seed on two sandy soils for 14 months in sloping tanks in a greenhouse. A gradient of 18 to 160 cm. to water table was maintained. Height curves for the two pines and for *Picea mariana* indicated distinct optimum depths to water table. *Picea glauca* performed differently, showing a pronounced response to early heavy surface watering of the upper slope area. Upper slope trends for the two pines and *Picea mariana* on the finer textured soil showed a gradual height increase, while those on the coarser soil showed no height increase to within short distances of the maxima. Height growth on the lower slope beyond the optimum depths declined rapidly in all species.

Only *Pinus resinosa* showed mortality at the minimum depth to water table on the sandy soil; this was related to its inability to produce sufficiently long laterals to extend into the less wet portion of the tank.

Black spruce on the upper slope of the sandy soil died when surface watering was discontinued after 1 year of growth; the killing was associated with its inability to form more extensive root systems in this soil.

Contribution No. 601, Forest Res. Br., Manitoba, Saskatchewan Dist. Off., Winnipeg, Manitoba,. Canada.

244. Jackson, L. W. R., and Hepting, G. H. ROUGH BARK FORMATION AND FOOD RESERVES IN PINE ROOTS. Forest Sci. 10(2): 174-179. 1964.

One of the principal symptoms of the littleleaf disease of shortleaf pine is a marked deterioration of the roots, as shown by the scabby appearance of the small laterals and excessive dieback of the mycorrhizae-bearing roots. In the advanced stages of the disease, an excessive and premature formation of rought bark termed "brown-patch" occurred on all roots. It appeared likely that brown-patch over large root areas could result in a serious loss of phloem where much of the reserve food is stored.

The vents were traced from the known reduced photosynthetic capacity of the littleleaf trees to the excessive formation of rough bark on the roots. The histology of brown-patch was described and illustrated with photomicrographs. Monthly analyses were run throughout a single year on the total carbohydrate content of root wood and bark to determine whether root starvation precedes and leads to formation of brown-patch. The food content of root bark on healthy trees reached a minimum in early fall and a maximum in early spring. Root bark on diseased trees had only half the food content of the healthy trees over the year. These data showed that excessive brown-patch formation follows the starvation of the phloem which resulted from either impeded syntheses or translocation of food.

U. Ga., Athens, Ga., 30601

245. Reukema, D. L. CROWN EXPANSION AND STEM RADIAL GROWTH OF DOUGLAS-FIR AS INFLUENCED BY RELEASE. Forest Sci. 10(2): 192-199. 1964.

A study of 32 felled and dissected codominant trees (29 released and 3 unreleased) in a 50-year-old *Pseudotsuga menziesii* stand in western Washington indicated that release tends to reduce rather than accelerate crown expansion during the first few growing seasons following thinning. This effect was most pronounced in the upper part of the crown. Moreover, when released and rereleased sides of a given tree were compared, no differences in branch elongation were apparent. Stem radial growth was increased by release, progressively improving lower on the stem. Apparently crown buildup was not a major contributing factor in the stem-growth response of released trees.

Pacific Northwest Forest and Range Expt. Sta., FS, USDA, Portland, Oreg.

246. Alexander, R. R. MINIMIZING WINDFALL AROUND CLEAR CUTTINGS IN SPRUCE-FIR FORESTS. Forest Sci. 10(2): 130-142. 1964.

A study of windfalls around the perimeters of 234 clearcut units in Picea engelmannii Parry-Abies lasiocarpa (Hook.) Nutt. forests identified many situations and conditions were windthrow hazards were above and below average.

The possibility of minimizing windthrow by cutting-area layout depends upon whether the area will be subjected only to normal wind exposure or whether it may be exposed to topographically accelerated winds. If wind exposure is normal, blowdown can be reduced by locating cutting boundaries where windfall hazards are below average. Where exceptional hazards from topographically accelerated winds prevail, the special wind problems may be handled in two ways: (1) Minimize all other hazards. Where the common practice of removing timber from one-half of the area in alternating units is to be followed, locate all boundaries, but especially the leeward boundaries where windfall hazards are below average. And (2) use a modified pattern of successive strip cutting in some high hazard areas to eliminate the vulnerable leeward boundaries by progressive cutting into the wind.

Rocky Mountain Forest and Range Expt. Sta., FS, USDA, Fort Collins, Colo.

247. Curtis, J. D. ROOTS OF A PONDEROSA PINE. U.S. Forest Serv. Res. Paper INT-9, 10 pp. 1964.

The root system of a 60-year-old, 67-foot-high ponderosa pine was excavated for examination in central Idaho. Soil removal was achieved by washing and careful picking. All main lateral roots were exposed, mapped, and measured. The taproot and sinker roots were traced as far as hardness of the substratum permitted—never more than 50 inches. Secondary laterals were tallied by 5-foot lengths along the main laterals. More than 73 percent of the primary and secondary laterals were located between 6 and 24 inches beneath the ground surface. Ninety-eight percent of secondary roots were 1 inch or smaller in diameter. Lengths of laterals varied from 45 to 797 inches. The root system extended over an area 5.4 times the size of the projected tree crown. More of the root system grew on the downhill side than on the uphill side.

Intermountain Forest and Range Expt. Sta., FS, USDA, Ogden, Utah.

248. Zahner, R., Lotan, J. E., and Baughman, W. D. EARLYWOOD-LATEWOOD FEATURES OF RED PINE GROWN UNDER SIMULATED DROUGHT AND IRRIGATION. Forest Sci. 10(3): 361-370. 1964.

Six Pinus resinosa Ait. trees, 20 years old and 21 feet in height, growing on a sandy Podzol in northern lower Michigan, were subjected to controlled soil moisture treatments. Three were irrigated to maintain soil at field capacity, and three were subjected to artificial drought by confining their roots under sheds. Terminal growth and cambial activity were measured in detail throughout one season of treatment. Annual rings in upper and lower boles were analyzed for gross anatomical features at the end of the season.

In lower boles, approximately 100 percent more xylem was formed in irrigated trees than in drought trees, both in wood volume and in numbers of tracheids. In the upper bole, about 50 percent more xylem was formed in irrigated trees.

Mork's definition latewood was greater in size of cells and in number at all stem positions in irrigated trees, but percentage of latewood was equal in both treatments at comparable stem positions. Initiation of flattened latewood cells began in late July at breast height for trees under drought, but not until late September for irrigated trees.

Cessation of needle elongation was not very well correlated with time of cell size changeover at breast height, but was correlated in the crown portion of the stem. Rates of needle elongation, however, could be related to tracheid flattening.

The relationships were discussed in terms of modern theories of wood formation, and both direct and indirect effects of water were considered.

U. Mich., East Lansing, Mich., 48823

249. Hurd, E. S. FROST FACTOR IN CHRISTMAS TREE PRODUCTION. Amer. Christmas Tree Growers J. pp. 16 and 51. Nov. 1963.

The Christmas tree grower isn't prepared to combat frost damage in the same manner as the cranberry grower or truck gardener. The balsam and spruce Christmas tree producer is therefore compelled to use greater precaution in selecting and developing his production areas. There are market demands and new interests being shown in planting of balsam fir and white spruce for Christmas tree production. The following generalities were offered to serve as guide lines for the establishment of fir and white spruce plantations:

1. That part of Wisconsin lying north of a line between Marinette and St. Croix Falls is characterized by average late and damaging spring frosts varying from May 15 to June 5. Damaging spring frosts occurred in north-central Wisconsin on June 16 in 1962 and June 20, 1963.
2. Balsam and spruce plantations established within the late frost zones should be selected with extreme care. Avoid planting in low and depressed areas (frost pockets) which serve as settling basins for cold air.
3. Planting on the north and east exposures of hillsides have a tendency to retard early spring growth thereby lessening possible frost damage to new-growth.
4. A certain amount of brush and overhead cover has a tendency to "Frost proof" and thereby minimize the amount of frost damage. Conversely, brush and overhead cover does not permit full sunlight which is vital for the development of dense foliage and good tree form. A compromise may be required and the grower must calculate the risk encountered in his own individual problem.
5. Nursery stock produced from seed collected in the late-frost area of the state should be favored over seed from localities not native to the frost zones.
6. Late spring frost, while causing injury to the new growth in balsam fir and white spruce causes degrading in quality, but is seldom a cause of tree mortality. Frost in early fall has no influence on tree quality of balsam and white spruce.

Past President, Wis. Christmas Tree Producers Assoc., Inc.

250. Ohman, J. H., and Kessler, K. J., Jr. BLACK BARK AS AN INDICATOR OF BIRD PECK IN SUGAR MAPLE. U.S. Forest Serv. Res. Paper LS-14, 8 pp. 1964.

Blackening on the lower bole of sugar maples is due to a fungus complex which includes Fumago sp., Pullularia pullulans, plus several as yet unidentified fungi growing together on the bark surface. They have dark mycelium and spores which, in mass, appear sooty-black to the unaided eye. Growth of the fungus complex has been observed following attacks by sapsuckers, porcupines, and small rodents. Limited areas of bark below some frost cracks also support the fungi. All of the incitants observed cause release of condiderable sap having a relatively high sugar content which saturates the dead bark and provides a food base for the fungi.

Sapsucker attacks were responsible for nearly all black-barked sugar maples examined, the other incitants being relatively minor. The wound pattern, part of the tree attacked, and time of wounding by sapsuckers differ considerably from the usual sapsucker attacks on hardwood trees. Sapsucker attacks on the lower bole of sugar maples were concentrated almost exclusively on these black-barked individuals in the stands examined, and all such trees dissected showed evidence of heavy and repeated attack.

Bird peck is a log grade defect in factory logs and such trees should be removed from northern hardwood stands managed for high-quality timber in order to concentrate growth on higher quality trees. The black-bark indicator can serve as a warning of possible bird peck defect in sugar maples, indicating that close inspection for bird peck is required.

Lake State Forest Expt. Sta., FS, USDA, St. Paul, Minn., 55101

251. Freeman, F. W., White, D. P., and Bukovac, M. J. UPTAKE AND DIFFERENTIAL DISTRIBUTION OF C^{14}-LABELED SIMAZINE IN RED AND WHITE PINE SEEDLINGS. Forest Sci. 10(3): 330-334. 1964.

A wide difference in the tolerance of red pine (Pinus resinosa Ait.) and white pine (P. strobus L.) seedlings to simazine has been observed. Carbon-14-labeled simazine was used to measure the possiblity of differential absorption and distribution of this herbicide. Seedlings were raised on mycorrhizae-free Prairie soil and inoculated Prairie soil. Forty days after treatment with labeled simazine, total uptake of simazine as estimated by counting C-14 assimilation was approximately equal for both pines. In red pine, the C-14 was fairly evenly distributed throughout the plant, but in white pine a much higher percentage was retained in the non-photosynthetic organs. The needles or red pine contained approximately 3 times more radioactive material (computed on percentage of total uptake) than white pine. The ratio of distribution of C-14 from top to roots of red pine was 1 to 1.4; in white pine it was 1 to 8.4.

Although mycorrhizae had developed only into the initial stages, autoradiograms and count data showed a much heavier concentration of C-14 in the noninoculated white pines. Counts in noninoculated plants were more than double those of inoculated plants, indicating that the presence of mycorrhizae may also enhance the resistance of white pine to simazine. No apparent differences were noted in simazine absorption between inoculated and noninoculated red pine.

Journal Article 3279, Agr. Expt. Sta., Mich. State U., East Lansing, Mich., 48823

252. Lake States Forest Expt. Sta. THE CAUSES OF MAPLE BLIGHT IN THE LAKE STATES. U.S. Forest Serv. Res. Paper LS-10. 15 pp. 1964.

In 1957, severe damage and mortality of sugar maple in Florence County, Wis., resulted in a strong cooperative research effort among Federal and State agencies and industry to determine its cause. Detection and appraisal surveys and insect, disease, and ecological studies were made. The following conclusions were made:

1. Much of the alarm about the maple blight problem at the time of its outbreak in Florence County, Wis., was based on the fact that the cause was unknown. Since no virulent pathogen was discovered, the chances are that any future outbreaks of maple blight will be sporadic and localized.
2. Insect defoliation was considered the primary cause of maple blight. The defoliation had to be early enough in the season so trees reflushed, and it had to be late enough so the reflush growth did not harden off at the end of the growing season. July to early August was considered the critical period for maple defoliation.
3. The webworm did the defoliating damage but a population of leaf rollers was essential to the development of a webworm epidemic because it lays its eggs only in rolled leaves.
4. Armillaria root rot appeared to increase the amount of postdefoliation mortality—mostly the mortality that occurs the second and third years after defoliation. Previously killed trees and stumps apparently provided the food base necessary in order for Armillaria to agressively attack living trees.
5. Below-normal soil moisture levels increased the severity of maple blight symptoms. Hence, defoliation coincidental with a period of drought increased damage.
6. Maple blight damage was more severe in understocked stands and in stands composed primarily of sugar maple.
7. The timing and severity of fall frosts following defoliation and reflush seriously affected the severity of maple blight damage.
8. Only stocking and stand composition lend themselves to indirect control or prevention of outbreaks of maple blight.

Lake States Forest Expt. Sta., FS, USDA, St. Paul, Minn.

253. Hard, J. S. THE IDENTIFICATION OF PRIMARY RED PINE CONE INSECTS. U.S. Forest Serv. Res. Paper LS-12, 10 pp. 1964.

At least six insect species cause primary damage to red pine seeds and cones in the Lake States. Keys and illustrations of cone damage and mature larval characters were presented to enable the forester, nurseryman, or entomologist to identify them. A chart was given that shows when larvea of the various species can be found in cones in the field. The red pine cone bettle, (*Conophthorus resinosea*) appears to be the most destructive species.

Lake States Forest Expt. Sta., FS, USDA, St. Paul, Minn.

254. Farrell, J. H. TIMBER INCOME POTENTIAL FROM SMALL FORESTS IN THE MISSOURI OZARKS. U.S. Forest Serv. Res. Paper CS-11, 74 pp. 1964.

The feasibility of growing timber on forested sites in the Ozarks where forage may be an alternative use has often been questioned. A report was given to help answer this question.

For managed timber stands the authors concluded that:

1. At today's stumpage prices with low production costs, site 2 hardwood landin the Missouri Ozarks can yield a profit to the owners of about $80 to $380 per acre per rotation period.
2. With high stumpage prices in the range of $30 to $40 per thousand board feet, which might be realized in future markets, and a hardwood pulp market for thinnings, net returns of about $380 to $630 per acre appear possible from such sites.
3. Even with high costs of management, if stumpage prices up to $40 are realized, hardwood stands on medium sites can net up to $265 per acre per rotation.
4. High management costs can be sustained by Ozark timber stands under some conditions. Because of potentially greater yields, more can be spent for production on the good timber sites than on poor ones. Cumulative total costs, including interest charges, may range from about $90 to $530 per acre over a rotation period for common management expenses encountered in the Region. Gross potential returns may range from $170 to about $725 per acre on Site 2 hardwood land and about $410 to $1,300 on similar-quality pine land under intensive management.
5. Ozark landowners who have managed their timber under a variety of conditions short of a full rotation, show net returns at maturity ranging from about $10 to $240 per acre.

For unmanaged timber stands the author concluded that:

1. Owners of typical hardwood timber stands on Site 2 land in the Ozarks today should not expect expect profit at present costs and stumpage prices over a rotation period if all they do is invest in land and pay taxes.
2. On the other hand, pure pine stands under similar conditions on Site 2 land can return a profit even without timber management.
3. At moderate costs, unmanaged hardwood stands producing as much as 3,500 board feet per acre at harvest would be marginal under the best conditions. Stumpage prices must rise more than threefold before a break-even point is reached.
4. Where fully stocked hardwood stands capable of producing maximum sawtimber yields can be found, stumpage prices greater than $15 per thousand board feet must still be realized, along with moderate costs, before net returns without management exceed the break-even point.
5. Hardwood land with trees averaging only one 16-foot log at maturity (Site 1) is submarginal for timber production without management under present-day cost and price conditions. What Site 1 land can do under timber management awaits further research on timber yield.

Owners of well-stocked forests who bought the land at low prices and pay low to average taxes are in an excellent investment position. Comparatively high net gains are possible at present cost-return ratios, particularly if investment periods are short and timber stands are managed. The cost-return ratio possible under management was about 1:3 on the small forests within this study.

Photographs, maps, charts, and tables.

Central State Forest Expt. Sta., FS, USDA, Columbus, Ohio.

255. Landt, E. F., and Woodfin, R. O., Jr. SAWMILL AND LOGGING RESIDUES FROM PONDEROSA PINE TREES. U.S. Forest Serv. Res. Note RM-23, 8 pp. 1964.

Results of measurements of 300 trees and 277 saw logs revealed that Black Hills ponderosa pine trees yielded from 77 to 79 percent of the tree weight to a 4-inch top diameter in residues of various kinds. Only 21 to 23 percent ended up as lumber. These proportions of residues and lumber were determined by the use of conversion factors developed for logging residues, sawmill residues, and planing residues for three kinds of circular headrig sawmills, and for both sound logs and logs with a scalable defect.

The defective logs without exception showed larger conversion factors than the sound logs. Significant differences were also found between the conversion factors for the various kinds of sawmill residues produced at three types of circular headrig sawmills. The largest amount of total residue was produced at sawmills with no resaws, but the largest amount of chippable residue was produced at the band resaw mills. Chippable residue yields ranged from one-half a unit at the gang resaw mills to two-thirds a unit at the band resaw mills.

The large volume of residues resulting from lumbering operations could form the basis for added income to mills if markets could be found. For example, assume a gang resaw mill cutting (from a random distribution of log diameters) 30,000 board feet of 4/4 rough lumber per day. This mill would produce in total, 72.7 tons of ovendry residue and the surface dry lumber would weight about 21.6 tons. The total residue would include 40.8 tons of sawmill residues, 11.7 tons of planing mill residues, and the harvesting of the logs would account for 20.2 tons of logging residues.

A stong demand for pulp chips could have a significant effect on the fuller utilization of Black Hills ponderosa pine sawtimber. If chipping sawmill and logging residues were found profitable, an additional 40 to 53 percent of the volume of the tree could be recovered. Several Black Hills mills have made a good start in this direction and are converting most of the sawmill and some logging residues into pulp chips.

Rocky Mountain Forest and Range Expt. Sta., FS, USDA, Fort Collins, Colo.

Windbreaks

256. Eimern, J. van. WINDBREAKS AND SHELTERBELTS. World Meteorological Organ. Tech. Note 57 (WMO-No. 147. TP. 70) 188 pp. $2.40. 1964.

The effects of shelterbelts and windbreaks on microclimate, soil climate, soil erosion, and on plants and animals were given.

The main effect of shelterbelts and windbreaks was to reduce surface wind speed. The change in microclimate and soil-climate, in plant growth and in animal life was mostly a consequence of the reduced wind speed. The horizontal range of wind reduction by a belt was proportional to the height (H) of the belt. The percentage wind reduction was independent of wind speed with small exceptions. The permeability of shelterbelts to air flow was the main factor affecting the distribution of wind speed on the leeward of the shelter. Very dense shelterbelts caused a strong reduction immediately behind the belts, connected with eddies and strong turbulence. The distance from the belt at which the free open wind speed was reestablished was relatively small. Behind shelterbelts with a permeability of 40 to 50 percent the zone of wind reduction was the most extensive. The minimum of wind speed was at a distance of four to six times the height of the belt. The degree of wind reduction by shelterbelts of different widths depended chiefly on their permeability. Other factors influencing the wind reduction by shelterbelts were the roughness of soil surface and the stability of the air. The range of wind reduction increased with decreasing surface roughness and with increasing air stability.

The layout of shelterbelts depends on their purpose. Consideration must be given to the proximity of adjacent belts as several parallel belts produce an effect different from that of a single isolated belt. Very frequently a rectangular network of shelterbelts gave the best wind reduction because of the variation in wind direction.

Radiation was reduced by shelterbelts only in the immediate vicinity. Generally a small increase in the daytime soil and air temperature behind shelterbelts was found. Shelterbelts increased the risk of late spring frosts on slopes where air drainage was impeded but had little effect on risk of radiation frosts in flat fields during calm nights. The influence of shelterbelts on air humidity was likewise not uniform. Generally an increase in relative humidity and in the amount of dew fall was observed at night. Shelterbelts had a large influence on the distribution of precipitation in their immediate vicinity but produced no significant increase in the amount of general precipitation in the sheltered area. In climates with severe winters and dry summers, the main purpose for planting shelterbelts is often for the accumulation of snow behind them. The formation of snow-drifts depends largely on the density of the shelterbelts.

The reduction of potential and actual evapotranspiration and of the loss of soil moisture by reducing the wind speed is frequently the main purpose of shelterbelts. The amount of reduction of evaporation is smaller than the reduction of wind speed because the evaporation depends on the square root of wind speed and also largely on the amount of radiation, which is not influenced by shelterbelts. Behind very dense belts the evaporation can increase in spite of wind reduction due to higher turbulence.

An increase in the CO_2- content of the air near the soil surface by shelter belts could not be found. The effect of belts on growth, yield, and quality of crops and fruits varied with climate, soil, and the type of plant itself. The main effect on yield was mostly due to the better water supply and frequently due to higher temperature. Fruits and vegetables and other special crops normally reacted better to wind reduction than cereals, forage plants, and other agricultural crops. The financial return of crops planted in a wind-sheltered area can also be increased by a better quality and earlier ripening.

The following other topics were discussed: Shelterbelt design; wind flow through gaps and at ends; problems in hilly areas; the influence of forests on wind; the complex problem of soil erosion control; and protection for farm animals, farm buildings, and pastures; and the planting, care, and maintenance of shelterbelts.

Sec. World Meteorological Organ., Geneva, Switzerland.

257. Grover, R. CHEMICAL WEED CONTROL IN SHELTERBELTS—A REVIEW. Tree Planters Notes, 66: 1-4. July 1964.

The major problem in the establishment and maintenance of shelterbelts on the Canadian prairies and on the Great Plains of the United States is control of weeds. Since the cost of hand hoeing miles of shelterbelts if prohibitive, control of weeds with herbicides apparently is the most practical means for the successful establishment and weedfree maintenance of shelterbelts.

Chemical weed control in shelterbelts can be divided into three main categories: (1) Weed control in new plantings; (2) weed control in established plantings; and (3) chemical site preparation.

Safe recommendations for the use of herbicides in shelterbelts can be made if their mode of action is known. A herbicide may be safe due to the inherent physiological and/or biochemical selectivity possessed by a certain tree species or just due to restrictions of the movement of the herbicide that prevents it from reaching the root zone of the tree. No tree species is known to possess inherent selectivity for any of the herbicides that have been tested for weed control in shelterbelts. Didario and coworkers (1960 & 1962) have shown that a large number of tree and woody ornamental species are quite tolerant to dacthal.

Since edaphic factors determine, in most cases, the nature of tolerance of tree species to various herbicides, a study of factors affecting the behaviour of these herbicides in soils is of utmost importance. Adsorption, volatilization, photodecomposition, microbial action, chemical reaction, and perhaps some other processes determine the behaviour of herbicides in soils. These processes, in turn, are dependent to a varying extent on soil type, soil moisture content, soil organic matter, pH of soils, and the nutrient status of soils. It is only after an understanding of most, if not all, of these factors and their interaction that safe and definite herbicide recommendations for weed control in shelterbelts can be made on a scientific basis.

Expt. Farm, Canada Dept. Agr., Regina, Saskatchewan, Canada.

Management of Coffee Plantations

SEE ALSO 212.

258. Jones, P. A., and Wallis, J. A. N. A TILLAGE STUDY IN KENYA COFFEES III. THE LONG-TERM EFFECTS OF TILLAGE PRACTICES UPON YIELD AND GROWTH OF COFFEE. Empire J. Expt. Agr. 31(123): 243-254. 1963.

A 15-year tillage experiment in Arabica coffee grown on a red volcanic latosol showed that weed growth during wet seasons consistently lowered the mean annual yield by between one-quarter and one-third; it also reduced the proportion of large beans. These losses were decreased by mowing the weeds or adding cattle manure. No relationship was detected between the trial results and rainfall, but the yield response to weeding was strongly, although irregularly, affected by the stage of recovery from the cyclic removal of the bearing stems of the coffee. Initially, higher yields were obtained from clean weeding with forked hand-hoes than from the use of tractor-mounted plows or disks, but during the final 5 years these differences disappeared. A tractor-mounted rotary hoe was developed that was superior to the forked hand-hoe, provided its use was associated with routine grass mulching.

Coffee Res. Sta., Ruiru, Kenya.

Fruit and Nut Crops

SEE ALSO 52, 106, 124, 125, 126, 127, 128, 129, 130, 131, 141, 155, 180.

259. Kender, W. J., Eggert, F. P., and Whitton, L. GROWTH AND YIELD OF LOWBUSH BLUEBERRIES AS INFLUENCED BY VARIOUS PRUNING METHODS. Proc. Amer. Soc. Hort. Sci. 84: 269-273. 1964.

Five pruning methods—standard oil burning, mowing, mowing plus herbicidal oil, herbicidal oil, and fortified herbicidal oil—were tested in two long-term experiments on lowbush blueberry plants in Washington County, Maine.

Yields were increased significantly in plots pruned by burning as compared with the other methods in one of the two experiments. Both burning and mowing followed by an application of herbicidal oil resulted in significantly higher yields than the other treatments employed in the second experiment.

Plant stand was significantly better in plots which were burned as compared with the other treated plots in one experiment. Results from the second experiment showed that the burn and mowing treatments resulted in the production of significantly higher numbers of stems than the oil treatments.

Yield and plant stand were poorest in plots pruned by means of herbicidal oil and fortified herbicidal oil in both experiments.

Pruning treatments which entirely destroyed the above ground portion of the blueberry plants (burning and mow-oil) caused new, vigorous stems to emerge from buds located on the underground rhizomes. Treatments which allowed portions of stems to remain intact above the soil surface (mowing) caused many new weak, unproductive stems to emerge from the basal buds of these above ground portions

With the use of oil alone, dead plants remained in place in the field and resulted in low yields and poor fruit quality the following year.

U. Maine, Orono, Maine, 04473

260. Piringer, A. A. INTERRELATION OF PHOTOPERIOD, CHILLING, AND FLOWER-CLUSTER AND RUNNER PRODUCTION BY STRAWBERRIES. Proc. Amer. Soc. Hort. Sci. 84: 295-301. 1964.

Fall-potted plants of the strawberry varieties Sparkle, Tennessee Beauty, and Missionary were moved from natural days in the coldframe to natural and long days in the greenhouse at monthly intervals from late October 1959 to mid-March 1960 at Beltsville, Md., and grown in the greenhouse until mid-summer. Natural daylengths during the experiment ranged from 10.9 hours down to 9.4 and then up to 14.9 hours. The long-day photoperiod was provided by a 3-hour incandescent light interruption near the middle of the natural night.

Missionary produced many more flower clusters on natural days with no previous winter chilling than Sparkle or Tennessee Beauty; and either long days or chilling before forcing reduced flower cluster formation with Missionary.

Sparkle and Tennessee Beauty adapted respectively for northern and central states, required both long periods of chilling in the coldframe and the long days of spring for runner production on natural days in the greenhouse. Missionary, adapted to the South, formed runners after little chilling and on the shorter natural photoperiods of mid-winter.

Plants of all varieties formed runners on long days without chilling. They formed fewer runners if they received a short period of initial chilling but many more runners if they received a prolonged chilling period. Missionary required the least and Sparkle the most chilling time for maximum runner production on long days.

CRD, ARS, USDA, Beltsville, Md., 20705

261. Uriu, K. EFFECT OF POST-HARVEST SOIL MOISTURE DEPLETION ON SUBSEQUENT YIELD OF APRICOTS. Proc. Amer. Soc. Hort. Sci. 84: 93-97. 1964.

The time at which the available soil moisture was depleted to the PWP (permanent wilting point) in unirrigated apricot plots and in those irrigated once after harvest was determined for the 1-6 foot depth soil profile. The low yields occurring in some years in the unirrigated treatment were associated with early depletion of soil moisture during the previous summer.

When the soil moisture did not reach the PWP until mid-August, yields the following year were not appreciably affected. However, when the soil moisture reached the PWP in early July and remained there, yields the following year were definitely reduced. When the soil moisture reached the PWP in mid-June and continued there throughout the summer, nearly complete crop failure occurred the year following. An irrigation in July effectively prevented crop reduction.

Adequate soil moisture at the time of floral bud differentiation in the immediate post-harvest period of late July and early August was essential, therefore, for satisfactory yields of apricots the following year.

U. Calif., Davis, Calif., 95616

262. Jones, W. W., Embleton, M. L., Steinacker, M. L., and Cree, C. B. THE EFFECT OF TIME OF FRUIT HARVEST ON FRUITING AND CARBOHYDRATE SUPPLY IN THE VALENCIA ORANGE. Proc. Amer. Soc. Hort. Sci. 84: 152-157. 1964.

Studies on Valencia oranges at two locations—Orange County and San Diego County, Calif., show that "on-tree storage" of fruit reduced the set and size of fruit in the subsequent crop. Carbohydrate accumulation in the leaves was also reduced.

Carbohydrate-fruiting relations were discussed and it was concluded that the mature fruits constituted a carbohydrate drain on the tree during the on-tree-storage period. Ways to minimize the detrimental effects of on-tree-storage are being studied.

U. Calif. Citrus Res. Cent., Agr. Expt. Sta., Riverside, Calif., 92502

263. Donoho, C. W., Jr. INFLUENCE OF PESTICIDE CHEMICALS ON FRUIT SET, RETURN BLOOM, YIELD, AND FRUIT SIZE OF THE APPLE. Proc. Amer. Soc. Hort. Sci. 85: 53-59. 1964.

Seven pesticide treatments were maintained in a Jonathan and Rome Beauty apple orchard during 1961-63, to determine the effect of fruit set, return bloom, yield, and fruit size.

Pesticide treatments that resulted in the largest fruit set and yields were: Combination of Captan + DDT; Glyodin + DDT; and Dodine + DDT. Trees consistently having the lowest fruit set and yields were those sprayed with Phix + DDT. Treatment of Phygon XL + DDT and Guthion + Captan also reduced fruit set and yields but not to the extent or as consistently as did the Phix treatment. Sevin + Captan reduced fruit set and yields only when the applications began at petal fall. Yields were comparable to the Captain + DDT treatment when the applications of Sevin were begun at a later date.

There was no consistent influence of the pesticide treatments on return bloom. Trees having reduced crops of fruit due to pesticide treatment had no larger return bloom than trees which had no reduction in yield or fruit set.

Fruit size was not influenced by the different pesticide treatments, except that the Jonathan trees receiving the Phix + DDT treatment had larger fruit 1 year only. In general, fruit size was favorable all 3 years regardless of pesticide treatment.

Ohio Agr. Expt. Sta., Wooster, Ohio.

264. Batjer, L. P., Williams, M. W., and Martin, G. C. EFFECTS OF N-DIMETHYL AMINO SUCCINAMIC ACID (B-NINE) ON VEGETATIVE AND FRUIT CHARACTERISTICS OF APPLES, PEARS, AND SWEET CHERRIES. Proc. Amer. Soc. Hort. Sci. 85: 11-16. 1964.

N-dimethyl amino succinamic acid (B-Nine) sprays applied to apples, pears, and sweet cherries had a pronounced retarding effect on shoot growth, and a marked increase in amount of bloom the following spring. The degree of growth reduction was related but not proportional to the concentration of the chemical. Reduced growth was accompained by shorter internodes resulting in as much as 80 to 100 percent more leaves per linear unit.

Increased flowering may have been due to the direct action of the chemical, rather than an indirect effect due to a greater foliage area per linear unit.

Other effects of B-Nine were reduction in fruit size, larger leaves, delay in blossoming, shorter fruit stems (Golden Delicious), and advanced maturity of sweet cherries.

CRD, ARS, USDA, Wash. State U., Wenatchee, Wash.

SEE ALSO 13, 40, 42, 43, 55, 56, 76, 77, 85, 91, 92, 94, 106, 110, 111, 112, 117, 123, 132, 135, 136, 139, 140, 143, 148, 154, 162, 166, 170, 177, 178, 181, 183, 190, 192, 193, 197, 198, 200, 202, 206, 207, 215.

265. Funk, C. R., and Anderson, J. C. PERFORMANCE OF MIXTURES OF FIELD CORN (ZEA MAYS L.) HYBRIDS. Crop Sci. 4(4): 353-356. 1964.

Blending of two or more corn hybrids, either in the same hill, in alternate hills, or in alternate rows, did not appear to increase grain yields over the mean of the component hybrids grown separately. Hybrids showed considerable differences in competitive ability, and the actual contribution of the individual components of a mixture differed widely from what would be expected on the basis of their yields in pure stands. An initial seedling advantage due to differences in planting date greatly increased competitive advantage in a mixture. Blending corn hybrids was found to increase yield stability with a decrease in the entry X location interaction.

Rutgers—The State U., New Brunswick, N.J.

266. Stickler, F. C. ROW WIDTH AND PLANT POPULATION STUDIES WITH CORN. Agron. J. 56(4): 438-441. 1964.

Both irrigated and nonirrigated trials designed to measure performance of corn in 20-, 30-, and 40-inch rows at varying plant populations were conducted in Kansas from 1961-63. Under irrigation, highest yields were obtained with either 20,000 or 24,000 plants per acre. Non irrigated corn yielded best at 16,000 plants per acre. Twenty-inch rows exceeded 40-inch rows in yield by 6 percent under irrigation and by 5 percent in nonirrigated trials. This superiority was associated mainly with more ears per 100 plants (more 2-eared plants and fewer barren plants).

Grain protein percentage in nonirrigated trials in 1963 decreased with increased stand density (increased yield) in 40-inch rows, but tended to remain rather stable over stand densities in 20- and 30-inch rows.

In 1963, leaf area portion (per-plant basis) was highly associated with grain yield per plant ($r = .895^{**}$), but was significantly influenced only by plant population and not by row width. It was suggested that yield advantages in narrow rows (20 to 30 inches) probably resulted from more ears per 100 plants (more multipe-eared plants and fewer barren plants) rather than from more net photosynthesis and higher grain yield per ear-bearing plant.

Agr. Expt. Sta., Kans. State U., Manhattan, Kans., 66504

267. Lillard, J. H., and Jones, J. N., Jr. PLANTING AND SEED-ENVIRONMENT PROBLEMS WITH CORN IN KILLED-SOD SEEDBEDS. Trans. ASAE 7(3): 204-206, 208. 1964.

A 1-year (1962) progress report on corn planting and seedling environmental problems in chemically killed sod seedbeds was given. A better understanding of many of the factors which must be dealt with in corn production with the no-tillage system was found. Some of the more important of these were summarized as follows:

1. A typical no-tillage seedbed prepared by chemically killing an existing cover crop generally had the following characteristics as compared with a conventionally tilled area: (1) A higher bulk density but more stable soil structure. (2) About 5° F. lower average maximum temperature in the seedling zone and a 4 to 6-degree less fluctuation between day and night averages

with very little differences in daily minimums. (3) More available water in the root zone throughout the season. It averaged 0.7 in. at Blacksburg. (4) A more rapid rate of plant growth and generally as high or higher grain and stover yields. And (5) superb erosion control and water-use efficiency to improved land use management.

2. Planter requirements for uniform performance and optimum seed germination in killed-sod, no-tillage seedbeds included: (1) Assisting tool(s) in front of the planter corn opener to insure uniform penetration, provide limited subsurface tillage in the immediate seedling environment zone, and remove enough dead sod from the row surface to minimize impedence to plant emergence; (2) a seed press wheel to firm the corn grains into the soil and a coverer to completely close the slit opened by the corn opener so as to eliminate air pockets in the vicinity of the seed; and (3) a press wheel of appropriate shape to firm the soil over the seed row.

Intensive controlled laboratory research will be required to determine more precisely how and why the natural differences in the no-tillage seedbed characteristics favorably influence corn production. Much more field testing and experience will be required to determine the specific tools and tool arrangements that most adequately meet the planting requirements under the range of cover and soil conditions encountered.

Agr. Expt. Sta., Va. Polytech. Inst., Blacksburg, Va., 24061

268. Porter, K. B., Atkins, I. M., Gilmore, E. C., Lahr, K. A., and Scottino, P. EVALUATION OF SHORT STATURE WINTER WHEATS (TRITICUM AESTIVUM L.) FOR PRODUCTION UNDER TEXAS CONDITIONS. Agron. J. 56(4): 393-396. 1964.

Short stature winter wheats yielded more than taller commercial varieties in irrigated trials and on dryland in a 35-inch rainfall area but about the same or less on dryland in areas having 20 to 25 inches of annual rainfall. One short wheat strain responded the same as the taller variety, "Concho", to differences in row spacing and planting rate but gave a greater yield response to a high rate of applied nitrogen. Quality characteristics were not associated with plant height.

Southwestern Great Plains Field Sta., CRD, ARS, USDA, Bushland, Tex., 79012

269. Jennings, P. R., and de Jesus, J., Jr. EFFECT OF HEAT ON BREAKING SEED DORMANCY IN RICE. Crop Sci. 4(5): 530-533. 1964.

Heat was used as a simple, effective, and practical means of breaking rice seed dormancy. Direct exposure of freshly harvested seed in envelopes to 50° C. for 4 to 5 days broke dormancy in most varieties. Exceptionally dormant varieties germinated readily after longer exposures of from 7 to 10 days. Nondormant varieties germinated normally following such treatment. The technique was further tested using thousands of coin envelopes containing varietal and segregating seed. Results were uniformly excellent.

High initial seed moisture contents do not hinder the loss of dormancy. Gradual loss of moisture content to extremely low levels inevitably occurs during the heat treatment without danger to seed. Exposure to as much as 65° C. for 10 days did not reduce viability and was only slightly less effective in breaking dormancy than the optimum temperature of 50° C.

Internatl. Rice Res. Inst., Los Banos, Laguna, Phillipines.

270. Huffaker, R. C., Akasha, M., Sarquis, A. V., and Miller, M, D. EFFECT OF 2,4-D ALONE AND IN COMBINATION WITH CHELATED AND NONCHELATED METAL ADDITIVES ON GROWTH OF FIELD BEANS (PHASEOLUS VULGARIS). Crop Sci. 4(6): 649-651. 1964.

The interaction of 2,4-D with the additive FeEDDHA on growth of beans was greatly dependent on the concentrations of each compound. At a predetermined growth inhibitory concentration of 2,4-D, FeEDDHA at 1/100,000 the concentration of 2,4-D completely reversed the inhibitory effect of 2,4-D on shoot length. Recovery of shoot dry weight was directly proportional to the concentration of FeEDDHA and was completely recovered only when the concentration of FeEDDHA was 100-fold greater than 2,4-D. Restoration of dry weight was a more realistic measure of recovery than was shoot length.

As the concentration of 2,4-D was increased to lethal ranges, the effect of FeEDDHA was progressively changed from that of protection, to no effect, to increasing the lethality of 2,4-D. Low levels of FeEDDHA behaved as protective agents against lethal concentrations of 2,4-D for only a short time (a few days) after which 2,4-D again became lethal. The implications of this were discussed.

Of several additives tested, FeEDDHA and EDDHA were very good protective agents against injury at described levels of 2,4-D.

M. D. Miller, U. Calif., Davis, Calif., 95616

271. Ford, J. H., and Zimmerman, D. C. INFLUENCE OF TIME OF FLOWERING ON OIL CONTENT AND OIL QUALITY OF FLAXSEED. Crop Sci. 4(6): 653-656. 1964.

The response of oil content and quality of flax seed to conditions at the time of flowering was measured in a 2-year field study. Both date of sowing and stage of bloom significantly influenced the oil content, iodine value, and fatty acid composition of the oil. The oil content, iodine value, and linolenic acid content were reduced and the oleic acid content increased as the date of sowing was delayed. The oil content tended to decrease as bolls were formed later in the blooming period, whereas, the iodine value and linolenic acid content increased. The response of iodine value to the stage of bloom remained constant despite fluctuations in the environment.

The daily maximum temperature during seed development inversely affected oil content and iodine value. The temperature accounted for a greater percentage of the total variation in oil content than it did in iodine value. The most critical or temperature-sensitive period for oil content and iodine value was the first 3 weeks after flowering.

Oil content was positively associated with iodine value and seed weight. A positive association was observed between iodine value and seed weight; when the influence of oil content was removed from this relationship, a negative association was revealed. Only environmental variation was included in the estimate of the relationships between characters.

CRD, ARS, USDA, St. Paul, Minn.

272. Corley, T. E., and Stokes, C. M. MECHANICAL COTTON HARVESTER PERFORMANCE AS INFLUENCED BY PLANT SPACING AND VARIETAL CHARACTERISTICS. Trans. ASAE 7(3): 281-286, 290. 1964.

The performance of two types of mechanical cotton harvesters, picker and stripper, was affected by plant spacing and variety.

In nonirrigated cotton, the average of eight tests showed no large differences in machinery efficiency because of plant population, but in three of the tests there was a significant linear trend of increasing efficiency with increasing plant population. In one test during a dry year, efficiency decreased as population increased.

Storm resistance appeared to be an important factor to consider in selecting a variety for mechanical harvesting, especially stripper harvesting. Open-boll-type varieties showing storm resistance had low preharvest or weather loss and still had high picker and stripper efficiency. The stripper was slightly more efficient than the picker, but this advantage was offset by other problems associated with stripper harvesting in Alabama.

In irrigated cotton, harvesting efficiency (picker) increased significantly as plant population increased; however, the increase in efficiency varied with variety. There were large differences in harvesting among varieties for the thin spacings but very little difference for the thick spacings.

For both irrigated and non-irrigated cotton, the characteristics of the cotton plant were materially altered by plant spacing. As plant population increased, plant height and limb length decreased, while height of fruiting increased. These characteristics were considered desirable for mechanical harvesting and were obtained at no sacrifice of yield. A stand of 20 to 60 thousand plants per acre was recommended for mechanical harvesting.

Auburn U., Auburn, Ala., 36830

273. Harris, V. C. LONG RANGE STUDY SHOWS THAT COTTON CAN BE GROWN WITHOUT CULTIVATION. Miss. Farm Res. 27(3): 3. 1964.

Annual weeds were satisfactorily controlled in non-cultivated cotton by a broadcast application of a preemergence and postemergence herbicide.

The cost of weed control by herbicides without cultivation was $3.41 less per acre than the cost of weed control by cultivation and hand-hoeing. Weed control with herbicides without cultivation returned $6.58 more per dollar invested in weed control than was the case with cultivation plus hand-hoeing.

Cotton weeded with pre- and postemergence herbicides without cultivation produced 572 lb./A. more seed cotton than that weeded with cultivation and hand-hoeing. The non-cultivated cotton plants fruited earlier and withstood drought longer than the cultivated cotton plants.

Mean yields and mean net returns per acre for 13 years of weeding with herbicides with no cultivation were significant at the 1 percent level of probability when compared to the weeding with cultivation and hand-hoeing of cotton.

Miss. State U., Agr. Expt. Sta., State College, Miss., 39762

274. Burnside, O. C., Wicks, G. A., and Fenster, C. R. INFLUENCE OF TILLAGE, ROW SPACING, AND ATRAZINE ON SORGHUM AND WEED YIELDS FROM NONIRRIGATED SORGHUM ACROSS NEBRASKA. Weeds 12(3): 211-215. 1964.

Experiments were conducted at Lincoln, North Platte, and Alliance, Nebr., during 1961-62 to determine the effect of tillage, atrazine, hand-weeding, and row spacings on RS 501 sorghum and weed yields. Combinations of tillage, narrow row spacings, and atrazine treatments gave more dependable weed control than any one alone. Sorghum yields increased and weed yields decreased with tillage and atrazine treatments. Preemergence atrazine applications as low as 1 lb./A. gave higher sorghum yields and lower weed yields than postemergence atrazine applications of 2 to 4 lb./A. Preemergence atrazine applications should be reduced on lighter soils because atrazine gives more effective weed control and increased sorghum injury on such soils. There was a 1 bu./A. decrease in sorghum yield for each 50 lb./A. of weeds present.

Agr. Expt. Sta., U. Nebr., Lincoln, Nebr., 68503

275. Wiese, A. F., Collier, J. W., Clark, L. E., and Havelka, U. D. EFFECT OF WEEDS AND CULTURAL PRACTICES ON SORGHUM YIELDS. Weeds 12(3): 209-211. 1964.

Sorghum grain yield losses in northwest and central Texas caused by uncontrolled weed growth varied from 8 to 41 percent. Under high moisture conditions, sorghum competed best with weeds when planted thickly in narrow rows. With less moisture, seeding in wide rows resulted in more effective competition. If rains produced weed germination immediately after planting, competition with the sorghum was more severe than when weeds germinated 1 or 2 months after sorghum planting. Several mechanical weed control methods were very successful.

Tex. Agr. Expt. Sta., Southwestern Great Plains Field Sta., Bushland, Tex., 79012

276. Dawson, J. H. COMPETITION BETWEEN IRRIGATED FIELD BEANS AND ANNUAL WEEDS. Weeds 12(3): 206-208. 1964.

In two experiments, beans were kept weed-free for various periods early in the season, and in a third, weeds were allowed to grow with beans for various periods before being removed. Weeds which emerged soon after planting caused extensive reductions in bean yields, but the actual yield-reducing competition occurred considerably later in the season. For 5 to 7 weeks after planting, the grower must control weeds by chemical or other means; for the remainder of the season, bean competition provides weed control.

CRD, ARS, USDA, Prosser, Wash.

277. Burnside, O. C., and Wicks, G. A. CULTIVATION AND HERBICIDE TREATMENTS OF DRY-LAND SORGHUM. Weeds 12(4): 307-309. 1964.

When weeds were controlled in sorghum by hand-weeding or a herbicide, there was no advantage or need for cultivation. Control of weeds in sorghum with preemergence herbicides was feasible, but the combination of cultivation and herbicides gave more dependable weed control than either method used alone. Preemergence application of atrazine were the most effective for controlling weeds and increasing sorghum yields. In decreasing order of effectiveness were: Propazine; CDAA + TCBC; and postemergence atrazine applications.

Nebr. Agr. Expt. Sta., U. Nebr., Lincoln, Nebr., 68503

278. Stickler, F. C., and Anderson, L. E. COMPARATIVE RESPONSE TO HERBICIDES OF GRAIN SORGHUM GROWTH AT DIFFERENT ROW SPACINGS. Crop. Sci. 4(5): 497-500. 1964.

In 1961-63 different herbicide treatments were evaluated in 20-inch and 40-inch rows of RS 610 grain sorghum at Manhattan, Kans. Conditions for herbicide action were ideal in 1961 and 1962 and somewhat less than ideal in 1963.

Grain yields were 12.6 percent higher and weed control was better in 20-inch than in 40-inch rows. Yield superiority of narrow rows was due primarily to more heads per unit area (more tillering), and secondarily to greater head size. Herbicide application required to give comparable weed control was lower in 20-inch than in 40-inch rows.

Of the basic treatments tested, atrazine applied soon after emergence gave the best weed control and highest grain sorghum yields. Weed control and yield response curves were curvilinear in nature with little or no further response in grain yield from plots beyond the 1 lb./A. rate. Yield increases associated with less weed competition were primarily due to increased head size and secondarily to more heads per unit area.

Agr. Expt. Sta., Kans. State U., Manhattan, Kans., 66504

279. Jones, G. E., Dubey, H. D., and Freeman, J. F. PERSISTENCE OF DIPHENAMID IN TOBACCO FIELD SOILS. Weeds 12(4): 313-315. 1964.

After 10 months, diphenamid residues were found throughout the 0-9 inch soil depth. In silt loam soils under climatic conditions prevailing in and around the bluegrass region of Kentucky, diphenamid residues in soils may be present at phytotoxic levels in the plow layer 10-11 months after application at rates required for weed control in tobacco.

Co. Agr. Ext. Agent, Owenton, Ky.

280. Sund, K. A. AN EVALUATION OF ATRAZINE, SIMAZINE, MONURON AND DIURON ON TEN HAWAIIAN SUGAR CANE PLANTATIONS. Weeds 12(3): 215-219. 1964.

Twelve treatments consisting of atrazine, simazine, monuron, and diuron applied alternately in a program pre- and postemergence to the weeds were evaluated on ten sugar cane plantations. Averaged data indicated that combinations including atrazine outperformed simazine in every instance and diuron was better than monuron on all plantations but one. Diuron was most effective on grasses, e.g., Digitaria spp. whereas atrazine was outstanding against Commelina diffusa Burm.

In a second study on the same plantations, an initial treatment of 5 lb./A. of atrazine followed by 3 lb./A. of diuron gave outstanding weed control on five plantations. Using 3 lb./A. of each material applied simultaneously had merit at times but some plantations required only a single application of either material. Net days of weed control obtained by diuron were inversely dependent on the amount of chemical adsorbed by the soil in both studies and total days control appeared to be dependent on ample rainfall in the second.

C. Brewer and Co., Ltd., Hilo, Hawaii.

Vegetable Crops

SEE ALSO 42, 53, 54, 75, 113, 134, 136, 137, 138, 140, 155, 165, 166, 168, 181, 207, 208, 209, 211.

281. Gavett, E. E. LABOR USED TO PRODUCE VEGETABLES: ESTIMATES BY STATES, 1959. USDA. Econ. Res. Serv. Stat. B. 341. 37 pp. 1964.

State estimates of the man-hours of labor used in 1959 on the major vegetable crops were given. Similar estimates are developed periodically after data from the agricultural censuses are available.

The periodic State estimates are weighted into regional averages which serve as benchmarks for annual series. Each year the regional averages of man-hours per acre of vegetables, together with comparable data for other crops and per head or unit of production of livestock, are applied to the estimates of acres, numbers, and production of crops and livestock, prepared by the Federal-State crop reporting system to arrive at total man-hours of labor used by enterprises for regions and the country as a whole. The total man-hours are converted to indexes which, together with comparable indexes of production, are used to compute indexes of production per man-hour. The aggregate man-hours are also used as the labor component in an index measure of total production inputs in farming.

Tables.

OMS, USDA, Inform. Div., Washington, D.C., 20250

282. Yamaguchi, M., Timm, H., and Spurr, A. R. EFFECTS OF SOIL TEMPERATURE ON GROWTH AND NUTRITION OF POTATO PLANTS AND TUBERIZATION, COMPOSITION, AND PERIDERM STRUCTURE OF TUBERS. Proc. Amer. Soc. Hort. Sci. 84: 412-423. 1964.

The effects of soil temperature on plant composition and growth, tuberization, tuber quality, and periderm formation were investigated. White Rose and Russet Burbank potato plants were grown at four soil temperatures with a 5° F. difference between night and day in constant temperature water baths set at 50°-55°, 60°-65°, 70°-75°, and 80°-85° F.

Shoot emergence was rapid at 70°-75° F. and delayed at 50°-55° F. soil temperature. Foliar growth was optimal at 70°-75° F. soil temperature. The concentrations of N, P, and K decreased in the petioles as the plants matured.

The optimum soil temperature for tuber formation was between 60° and 75° F. Many stolons were initiated but tuberization was delayed early in the growth period at the lowest soil temperature. At 80°-85° F., tubers that developed near the soil surface were misshapen, and often several tubers formed on a single stolon.

The yield, specific gravity, and starch content of the harvested tubers of both varieties were highest and the sugar content lowest at the two intermediate soil temperatures.

Russet Burbank tubers from plants grown at the higher temperatures had well-russeted skin, while those from the lowest temperature had little or no russeting. Histological observations showed that the periderm was thickest in tubers grown at the highest soil temperature and thinnest in those grown at the lowest soil temperature. Russeting appears to be due to masses of cork cells which adhere tenaciously and are not easily sloughed off.

U. Calif., Davis, Calif., 95616

283. Paterson, D. R., and Speights, D. E. INFLUENCE OF CROP ROTATION, FERTILIZER AND VARIETY ON YIELDS AND CRACKING OF SWEET POTATO ROOTS. Proc. Amer. Soc. Hort. Sci. 84: 431-435. 1964.

Two soil rotation treatments, using land that had been in pasture for a least 11 years and land that had produced a crop of sweet potatoes that previous year were interacted with the Porto Rico, Copperskin Goldrush, and Redgold sweet potato varieties and a 3 X 3 X 3 NPK complete factorial experiment on an Izagora fine sandy loam soil at Hearne, Tex. in 1960.

Growing sweet potatoes for 2 years on the same soil reduced the percentage of No. 1 roots from approximately 33 to 12 percent of the total yield. The total yields of the Porto Rico and Copperskin Goldrush varieties were reduced more than the total yield of the Redgold variety on the continuous sweet potato rotation.

Both the No. 1 and total yields of sweet potatoes were increased as the rates of N fertilizer were increased from 0 to 50 to 100 lb./A. on the first year of sweet potato rotation. On the second year of continuous sweet potatoes, only the 50 lb./A. rate of N increased total and No. 1 yields. There was no response to P or K in this experiment either in individual grades or in total yields.

Tex. A&M U., College Station, Tex., 77841

284. Wester, R. E. EFFECT OF SIZE OF SEED ON PLANT GROWTH AND YIELD OF FORDHOOK 242 BUSH LIMA BEAN. Proc. Amer. Soc. Hort. Sci. 84: 327-331. 1964.

Experiments on the relation of seed size to plant growth and yield with Fordhook 242 lima beans gave the following results:

1. Size of seedlings, height of plants, and fresh weight of plants and yield were associated with size of seed.
2. Plants from small seed yielded considerably more when not crowded by large plants from medium and large seed in the field. This also occurred with medium sized plants from medium sized seed.
3. Plants from large seed always produced the largest plants with the largest number of beans per plant.
4. Plant size and number of beans produced from large seeds were not affected by size of adjacent plants.
5. Height of plants grown in the greenhouse were associated with length of internodes.
6. The internodes of plants were longest on plants from the largest sized seed; of medium length from medium sized seed; and shortest from the small seed.
7. Number of nodes per plant was not affected by seed size.

CRD, ARS, USDA, Beltsville, Md., 20705

285. Menges, R. M. RESPONSES OF SPINACH TO PREEMBERGENCE HERBICIDE TREATMENTS ON FURROW- AND OVERHEAD-IRRIGATED SOILS. Proc. Amer. Soc. Hort. Sci. 84: 446-454. 1964.

Three field experiments were conduced to study the performance of preemergence herbicide treatments in overhead- and furrow-irrigated spinach.

On furrow-irrigated silty clay loam, residual applications of 6 lb./A. of chlorazine controlled broadleaved weeds without injuring spinach; 3 lb. failed to control weeds. Chlorazine plus CIPC and chlorazine plus CDEC controlled weeds without spinach injury. Both rates of CIPC, CDEC, monuron, and diuron failed to control weeds. Contact applications of 12 lb. of OCH controlled weeds without injury, whereas the 8-lb. rate and also Stoddard solvent and diesel oil failed to control weeds. Applications of CDEC to the soil had no discernible effect on the taste of spinach, whereas those of diuron had a slightly objectionable effect.

On overhead-irrigated clay, residual applications of 6 and 8 lb./A. of CDEC controlled broadleaved weeds without reducing yield of spinach; 4 lb. failed to control weeds. These treatments and all others decreased the stand. Diuron at 1/3 lb. and chlorazine at 4 lb. controlled weeds without reducing yield; higher rates reduced yield. Applications of 4 lb. of CDEC plus 1/3 lb. of diuron controlled weeds without reducing yield. Five other combination-herbicide treatments controlled weeds but reduced yield. EPTC and CIPC decreased the yield at rates that failed to control weeds. Applications of 6 and 8 lb. of CDEC to the soil had no effect on flavor of freshly cooked or canned spinach.

On overhead- or furrow-irrigated fine sandy loam, the 4- or 8-lb. rates of CDEC had no significant effect on the growth of spinach. Identical rates of CIPC severely injured spinach with overhead irrigation but had little effect on growth with furrow irrigation. The 4-lb. rate of EPTC had no effect on spinach regardless of irrigation method; the 8-lb. rate caused appreciable injury only with overhead irrigation. The three herbicides penetrated the soil to the seed zone of spinach only with overhead irrigation. Applications of 8 lb./A. of CDEC had no discernible effect on the taste of spinach regardless of the irrigation method.

CRD, ARS, USDA, Weslaco, Tex.

286. Weinhold, A. R., Bowman, T., and Bishop, J. UREA-FORMALDEHYDE FOR THE CONTROL OF COMMON SCAB OF POTATO. Amer. Potato J. 41(10): 319-321. 1964.

A series of field tests over a period of four growing seasons showed that Urea-formaldehyde (Uracide) when applied into the furrow at time of planting provided a very effective control of potato scab. The most satisfactory rate of application to obtain control without phytotoxicity appeared to be 20 gal./A. Rates of 25 gal./A. and above resulted in reduced yield. The material was effectively applied at time of planting by the use of spray nozzles mounted directly on the potato planter and directed into the furrow just in front of the dropping seed pieces.

U. Calif., Berkeley, Calif., 94720

ECONOMIC AND SOCIAL ASPECTS OF SOIL AND WATER CONSERVATION

Costs and Returns

SEE ALSO 42, 56, 58, 59, 72, 170, 203, 221, 234, 237, 242, 254, 256, 273, 281.

287. Weeks, E. E. MAXIMUM PROFIT DAIRY RATIONS THAT INCLUDE WHEAT. J. Farm Econ. 46(3): 580-587. 1964.

Some results were given of research at Washington State University designed to estimate conditions under which wheat would be fed to livestock in the Pacific Northwest at given prices and nutritive characteristics of commonly available feedstuffs. Solution of the linear programming model developed maximized net returns of feed costs by selecting both the dairy cow and her ration from the alternatives in the model.

Solutions were obtained by parametrically varying wheat price. Wheat was allowed to be no more than half the grain part of the ration. With wheat price at $1.05-$1.28 per bushel, 750 pounds of it would be fed, and with wheat price at $1.29-$1.30 per bushel, 660 pounds would be fed per year. Wheat displaced barley prices at $1.01 per bushel. If, also, the level of barley use was restricted to half the grain fed, wheat replaced oats priced at $.76 per bushel. With wheat price at $1.49-$1.53 per bushel, 120 pounds of wheat would be fed, and with wheat price at $1.05-$1.48 per bushel, 750 pounds would be fed per year.

Corn, milo, and wheat millfeed also were very sensitive to price competition with oats and with wheat priced between $1.50 and $1.55 per bushel.

Wash. State U., Pullman, Wash., 99163

288. Miller, T. A., and Nauheim, C. W. LINEAR PROGRAMMING APPLIED TO COST MINIMIZING FARM MANAGEMENT STRATEGIES. J. Farm Econ. 46(3): 556-566. 1964.

The use of minimum cost linear programming techniques with reference to a Great Plains wheat farm was illustrated. The optimum organization of enterprises developed by minimum cost and profit maximizing strategies of management on the same farm was compared and interrelationships between results of these two modes were discussed.

In general, the minimum cost technique may be used to provide the research worker with knowledge of a wider range of possible outcomes than profit maximizing models used alone and hence may be more useful in a predictive sense than profit maximizing techniques. Application of the minimum cost technique to other problems to which it is especially well suited was also discussed.

FERD, ERS, USDA, Ames, Iowa.

Institutional, Educational, and Social Factors Affecting Conservation Application

SEE ALSO 1, 203, 204, 205.

289. Butcher, W. R., Heady, E. O., and Rigler, L. G. THE CONSERVATION RESERVE IN SOUTH-CENTRAL IOWA. Iowa Agr. Expt. Sta. Res. B. 523: 71-99. 1964.

The Conservation Reserve land-retirement program used the retirement of whole-farm units under long-term contracts to achieve the goals of production control, soil conservation, and furtherance of adjustments in agriculture. Land was accepted into the Conservation Reserve during the period 1956-60. Some contracts will continue in force until as late as 1970.

The achievements of the Conservation Reserve in south-central Iowa where about 5 percent of the farms had land in the program has been evaluated since 1959. The analysis was divided into two parts: (1) Determination of the characteristics of the participants and of the factors that were conducive to participation; and (2) estimation of the effect of the program on participants and on the agriculture of the region. Interviews with a sample of 153 participants in the program and with 107 nonparticipants provided data for the analysis.

Owners of farms with below-average yields were more likely to participate in the Conservation Reserve than were owners of farms with average or above-average yields.

A resource structure that could easily be transferred from farm to nonfarm use also was commonly found among participants, especially among those who retired whole farms. Paticipants in that group had been using, on the average, only about half as much labor for crop production when they were farming as had nonparticipating farmers or participants who continued to farm some cropland. Furthermore, those who put all their land into the Conservation Reserve tended to be farmers with close alternative uses for their labor. Twenty-five percent of the participants (three times as many as among nonparticipants) already had full-time off-farm jobs before they entered the program; 54 percent (twice as many as nonparticipants) were 60 years of age or older.

Participants who entered all their farmland in the program also typically had small investments in livestock, machinery, and buildings. Fifty-three percent had less than $1,000 worth of machinery. Thirty-seven percent had no livestock. Nineteen percent had no occupied dwelling on the farm.

Participants who continued to farm after entering the Conservation Reserve generally had opportunity to continue to use resources in their farming operation. The only statistically significant difference between participants who continued to farm and nonparticipants was a slightly smaller machinery inventory among the participants.

Nonoperating landlords were in an unusually good position to benefit from the Conservation Reserve. Since they furnished few nonland resources, with the exception of farm buildings, the idling of cropland had little effect on the possibility of continued returns from other resources. A provision designed to prevent widespread eviction of tenants by landlords who wanted to put land into the Conservation Reserve apparently deterred participation by landlords.

The direct effect of the Conservation Reserve was an immediate reduction in the acreage of land cultivated. On 66,000 Conservation Reserve acres, the estimated reductions were: corn, 22,000 acres; soybeans, 10,000 acres; oats, 11,000 acres; forages, 23,000 acres.

The actural decrease in land used for crops from 1954-59 was about 20 percent less than the acreage in the Conservation Reserve. An increase in the total acreage of cropland and Conservation Reserve land combined and a decrease in the acreage of idle cropland both served to partially compensate for the land taken out of production by the program. Among crops, the long-run shift out of oats production has made it possible for total soybean and hay acreages in the area to increase, even though harvested acreages of those crops were considerably reduced on Conservation Reserve farms.

Only part of the impact of the Conservation Reserve on livestock production could be estimated. Participating farmers reduced livestock production by an amount, requiring annually, about 397,000 feed units. Feed production was reduced by about 2,000,000 units.

Farm labor needs in the area were reduced by an estimated 350,000 hours or 75 man-years (at 2,000 hours per year) through the effect of retiring 66,000 acres of cropland in 820 Conservation Reserve contracts. Despite the large amounts of labor released by the Conservation Reserve, there was little switching from farm to nonfarm work by those who signed up in the Conservation Reserve.

Most participants kept their machinery and continued to occupy farm buildings.

Tables and charts.

Agr. and Home Econ. Expt. Sta., Iowa State U. of Sci. and Tech., Ames, Iowa., 50010

290. Lucas, R. C. THE RECREATIONAL CAPACITY OF THE QUETICO-SUPERIOR AREA. U.S. Forest Serv. Res. Paper LS-15, 34 pp. 1964.

The Quetico-Superior wilderness lakeland has been both preserved and restored. It was one of the earliest areas of wilderness preservation; the two halves of the area one on each side of the international border, were both established in 1909, and the value of their wilderness character was officially recognized by the 1920's. Inappropriate uses have been progressively restricted since then.

Capacity—the number of visitors and their degree of satisfaction—seemed to be more a function of attitudes than of physical factors. Attitudes seemed to be related to the craft used—boat or canoe. Canoeists were seeking wilderness, viewed a small area as wild, wanted this area kept undeveloped, and disliked heavy use. However, canoeists seemed willing to accept roughly three times as much canoe use as mixed boat and canoe use. Among other user types, none cited wilderness as an attraction in over half the interviews, although auto campers came close to this level. All user types except canoeists saw a large area as wild, were tolerant of relatively heavy use, and did not differentiate particularly between types of visitors encountered.

From the assumptions made for measuring capacity, total use in 1961 was only about 5 percent less than total capacity. Because of the unevenness of the distribution of use, however, large areas could have been used more often without a loss of wilderness qualities, while severe overuse was found elsewhere. A 55- to 60-percent increase in total use would probably not seriously detract from the wilderness environment if it all occurred at the underused accesses. Eliminating motorboats in the interior would apparently make possible 80- to 90-percent increase in use.

When past trends were projected and compared to capacity, serious problems appeared not too distant. If no access could be overused, full wilderness capacity has alread been exceeded. A more realistic estimate places the disappearance of full wilderness between 1965 and 1975. Levels of use considered consistent with wilderness by the less demanding half of the paddling canoeists would be experienced only a little later—between 1968 and 1982. There would still be some underused access points, lightly used interior lakes, and fewer visitors in spring and fall even in 1982, if the present relative distribution in time and over the area did not change substantially.

If use continues to climb, the wilderness, like a shallow desert lake drying up, will first retreat to the interior, then break up into small isolated areas, and finally disappear, first for canoeists, and considerably later for other types of visitors.

Lake States Forest Expt. Sta., FS, USDA, St. Paul, Minn.

291. Rosenthal, E. P. OUTDOOR RECREATION; CURRENT PERIODICALS. U.S. Dept. Int., Dept. Library Ref. Serv. Unnumbered Rpt. 16 pp. June 1964.

A listing of abstracting and indexing services and periodicals was given that contains references or information on outdoor recreation.

Dept. Library, U.S. Dept. Int., Washington, D.C.

BIOLOGY

Fish

SEE ALSO 308.

292. Carroll, B. B., and Hall, G. E. GROWTH OF CATFISHES IN NORRIS RESERVOIR. J. Tenn. Acad. Sci. 39(3): 86-91. 1964. Sport Fisheries Abstract 9(4): 206. 1964.

Spines from 254 flathead and 87 channel catfish were used to determine growth rates of these two species in Norris Reservoir.

Flathead catfish averaged 5.2 inches in total length at the end of their first year and 9.4, 13,8, 18.6, 23.2, 26.4, 29.0, 31.3, 33.1, 34.6, 37.3, 39.0, 39.7, 39.9, 40.8, and 42.0 inches, respectively, at the ends of succeeding years. Channel catfish averaged 3.9 inches of total length at the end of their first year and 6.9, 10.7, 12.8, 14.7, 16.7, 18.0, and 21.3 inches, respectively, at the ends of succeeding years.

Length-weight relationships show flathead catfish weigh approximately 0.4 pound at 10 inches, or minimum harvestable size, 2.1 pounds at 20 inches, 13.5 pounds at 30 inches, and 25 pounds at 40 inches. Channel catfish weigh approximately 0.3 pound when they reach 10 inches, 1 pound at 15 inches, and 4 pounds at 21 inches.

Some evidence of accelerated growth was found in three- to five-year-old flathead catfish after an extreme water-level drawdown in the winter of 1955-56, but growth of younger fish remained average or below.

Growth acceleration was not evident in older channel catfish but fish of the 1956 year-class were longer at all ages than those of 1954 and 1955.

Little is known about the present catfish harvest in Norris, but it is assumed to be light since there is no commercial fishing and sport catches are largely incidental. From this growth study no regulation appears necessary.

TVA, Norris, Tenn.

293. Walker, C. R. DICHLOBENIL AS A HERBICIDE IN FISH HABITATS. Weeds 12(4): 267-269. 1964.

Application of 20 to 40 lb./A. dichlobenil made prior to emergence accomplished various degrees of control of pondweeds (*Potamogeton diversifolius*, *P. foliosus*, *P. pectinatus*, *P. pusillus*) and a slender naiad (*Najas flexilis*). Coontail (*Ceratophyllum demersum*) was affected only by the higher dosage. Limited control and growth inhibition was achieved on several forms of algae in early spring applications. However, applications made to rooted submersed aquatic plants and filamentous algae (*Cladophora*, *Pithophora*, and *Chara*) at postemergence stage of development had little herbicidal effect.

Dichlobenil was not acutely toxic to fish at herbicidal concentrations. The range of median tolerance limits was 10 to 20 p.p.m.w. for pumpkinseed (*Lepomis gibbosus*), bluegill (*L. macrochirus*), redear sunfish (*L. microlophus*), and largemouth bass (*Micropterus salmoides*).

Fish Control Lab., Bur. Sport Fisheries and Wildlife, U.S. Dept. Int., La Crosse, Wis.

Upland Wildlife

SEE ALSO 1.

294. Browning, B. M., and Lauppe, E. M. A DEER STUDY IN A REDWOOD-DOUGLAS FIR FOREST TYPE. Calif. Fish and Game 50(3): 132-147. 1964.

A two-phased study was made of the relationship between blacktailed deer, and the reproduction of the principal timber-producting trees in the coastal redwood-Douglas fir forests of California. From 1959-63, two deerproof exclosures were constructed on the property of the Rockport Redwood Company in Mendocino County. A total of 328 trees was tagged and measurements recorded yearly. A total of 121 deer stomachs was analyzed for food items. Data on reproduction, age, condition, disease, and parasites were obtained as these animals were processed.

Young conifers outside of the deerproof exclosurers averaged 2.7 inches growth per year and made a 166 percent growth increase over the 4-year period. Protected, the trees averaged 8.0 inches per year and made a 410 percent growth increase to an average height of 39.8 inches. On a supplemental plot adjacent to the principal study area, the protected trees made a 601 percent growth increase to an average height of 50.5 inches.

Observations showed that a young conifer was able to "escape" deer damage at a height of about 3 to 4 feet. Based on the average growths per year, unprotected trees would require as long as 20 years to reach the escape height.

Stomach analyses indicated a definite seasonal pattern in feeding habits. Grass, horsetail, oak mast, madrone, coast whitethorn, California huckleberry, tobacco brush, and Douglas fir were significant food items in the ecology of the Rockport deer. The greatest pressure exerted by the deer upon the conifers came during a rather limited period in the spring, generally coinciding with the trees' growing period.

The study showed that deer numbers need to be controlled in reforestation areas of the coastal redwood-fir forests of California.

Calif. Fish and Game.

295. Kline, P. D. NOTES ON THE BIOLOGY OF THE JACKRABBIT IN IOWA. Iowa Acad. Sci. Proc. 70: 196-204. 1963.

White-tailed jackrabbits (Lepus townsendii campanius Hollister) are found throughout Iowa with the exception of a few southeastern counties. Over much of their range they are relatively rare. They appear in greatest abundance on the recently glaciated soils in northern and central counties, and on the Missouri loess soils of the west-central counties. Dry growing seasons seem conducive to hare abundance; populations decline during wet seasons. Jackrabbits provide considerable hunting sport during winter. Their pelts are utilized in felt manufacture and their flesh as a staple food for ranch mink. They are known to eat sprouting corn and soybeans, and occasionally damage shrubs and trees. Populations of 114 and 90 jacks per square mile were recorded, but high populations of near 30 jacks per square mile were more common. Average populations over the more favorable portions of their range seem to fall between 5 and 15 per square mile.

Average winter weights of 7.5 and 7.9 pounds for males and females respectively were recorded. These contrasted with spring weights of 6.8 and 8.3

Sex ratios were essentially even. Breeding activity begins late in February in most years but may be delayed by deep snow and cold temperatures in March. Two and possibly three or four litters per year are produced per female. Litters average 3.6 young rabbits each, and range from one to five. Corpora lutea average 5.75 per pregnancy and range from three to eight. A considerable loss of ova was suggested by the data.

Iowa State Conserv. Comn., Des Moines, Iowa.

296. Mallette, R. D., and Harper, H. T. POPULATION STUDIES OF RING-NECKED PHEASANTS IN CALIFORNIA. Calif. Fish and Game, 50(4): 292-304. 1964.

The ring-necked pheasant populations were studied in two areas: (1) The Sutter Basin, Sutter County, Calif., consisting of 68,000 acres of intensively farmed agricultural land in Sacramento Valley; and (2) the 2,092-acre Fleming Unit of the Honey Lake Waterfowl Management Area, 4 miles west of Wendel, Lassen County, Calif. Information was obtained from trapping, banding, and band return data from 21,098 wild pheasants for a 10-year period (1952-61), and 56,777 game farm reared pheasants for an 8-year period (1950-57). Band returns and retrapping returns totaled 28,510.

Mortality rates were estimated by a method developed by Hickey. Pheasant loss rates in the Sutter Basin study area indicated juvenile males were at 86 percent the first year with a mean annual rate of 65 percent. Adult female mean annual rate of loss was 58 percent. The mortality rate for a stable pheasant population was estimated at 73 percent annually. Survival of pheasant chicks was greater for those hatched earlier in the season. Rates of mortality calculated from retrapped wild birds compared closely with the rates from band return data. The oldest band return recovered during the study was one female banded as a junenile 6 years before.

Loss rates were computed for the 3-year period when hens could be taken during the regular season and compared with the 4 years when only limited hen shooting on licensed pheasant clubs existed. The results indicated no adverse effects to the wild pheasant breeding population. Rates of loss were similar under the two hunting conditions.

The mortality rate of game farm reared birds was extremely high for both sexes the first year released; 95-99 percent. After surviving 1 year in the field, the rate of loss was somewhat comparable to that of wild birds.

Mortality rates of wild birds on the Honey Lake Waterfowl Management Area study area, estimated from band returns, indicated a mean annual loss rate of 86 percent for juvenile females, and 72 percent for adult females. Results were similar to those in Sutter Basin for males, with a higher mortality rate for the females, but the same rate of 73 percent for the mean annual mortality rate for the population as a whole.

A graphic illustration of the annual pheasant population fluctuations was calculated for Sutter Basin during a 6-year period (1953-58). Using the Lincoln and Kelker indices, a population was calculated with a 39,000-bird hatching peak, to a low of 12,000 birds at the breeding season annually.

Survival, hunting, and non-hunting mortalities based on wild pheasant band returns were calculated for Sutter Basin (1952-57) and Honey Lake (1955-58). Annual population survival was approximately 23 percent, hunting loss approximately 28 percent, and non-hunting mortality 49 percent in Sutter Basin. Honey Lake study area results for a comparable period indicated a 17-percent annual survival with 40 percent hunting loss and 43 percent non-hunting loss.

Calif. Dept. Fish and Game.

Wetland Wildlife

SEE ALSO 1, 308.

297. John, L. R., and Hunt, R. A. DUCK AND COOT ECOLOGY AND MANAGEMENT IN WISCONSIN. Wis. Conserv. Dept. Tech. B. 33, 212 pp. 1964.

Wisconsin has an estimated 1,170,698 acres of inland aquatic habitat of importance to ducks and coots, in addition to 9,878 sq. miles of Great Lakes' waters. Habitat quality varies regionally and locally. Considered solely on the basis of aquatic plants, southern hard-water lakes can support 17 to 2,250 times more duck use than northern soft to medium-hard water lakes.

Crude estimates placed the average yearly breeding duck population at 133,500 to 280,500 and duckling production at 217,100 to 456,300 (1949-50). Indicated statewide densitities per sq. mile were 2.6 breeding pairs of ducks and 0.5 of coot (1949-50). The blue-winged teal, mallard, and ring-necked duck averaged 84 percent of the breeders (1948-56). Productivity of ducks on the better quality Wisconsin wetlands balanced or exceeded total mortality.

Chronology of fall duck use for each species using Wisconsin was similar among years, but the pattern varied among species. Statewide, the bulk of the ducks and coots were present between October 10 and November 10. Important fall concentration sites were limited in number for only the ruddy duck, canvasback, and redhead.

Main Mississippi Valley fall flight routes of American widgeon, bluewinged teal, canvasback, lesser scaup, ring-necked duck, ruddy duck, and coot cross Wisconsin. Many mallards using the state in the fall very likely come from Manitoba and Ontario where water conditions are more stable than on the western prairies. Segregation of sexes and possibly an earlier migration of one sex were indicated for immatures of 5 species of ducks. Migration of adult female ducks appeared to coincide with the Wisconsin hunting season and resulted in a disproportionately heavy harvest of hens for many species. This differential loss probably helps explain the excess of males in the adult class of the duck population.

Wisconsin's wintering population consisted of an annual average of 33,700 ducks and 1,200 coots (1954-58). The mallard, black duck, common goldeneyer, and lesser scaup averaged 89 percent of the population.

Waterfowl hunting pressure in Wisconsin was high, with over 100,000 duck stamps sold annually (1948-60). Peak numbers of hunters were afield on the opening 2 or 3 days of the season and on subsequent weekends. Excessive numbers of hunters on some Wisconsin hunting areas force waterfowl to leave suitable habitat.

The daily bag limit of four was of greatest importance in limiting and distributing the duck kill on the first 2 days of the season and on areas of light hunting pressure. Reported duck crippling loss averaged 22 percent and was highest when hunting pressure was greatest and for pass shooting, and was not different for parts of the day. Coot crippling loss averaged 5 percent.

Hunters frequently misidentified bagged ducks. Most common waterfowl hunting violations involved daily shooting hours, improperly plugged guns, and closed seasons (1955-57). Waste of the resource included: (1) Wood ducks shot accidentally by hunters during closed seasons; and (2) coots shot for target practice in open seasons.

Refuges are needed in Wisconsin in fall to protect ducks from excessive disturbance caused by hunters, fishermen, and motor boat users. Small refuges (under 10,000 acres) are not effective in reducing hunting mortality on local breeding ducks.

The contribution of local ducks to Wisconsin's duck harvest (454,000) was estimated at 9 percent in a year of low production and 18 percent in a year of high production (1948-60).

Most important of 16 recommendations offered to guide management of seasonal populations of ducks and coots in Wisconsin were (1) Maintaining and developing suitable habitat; and (2) providing the birds with protection from excessive disturbance.

Wis. Conserv. Dept.,Madison, Wis.

298. Krammes, J. S., and Willets, D. B. EFFECT OF 2,4-D and 2,4,5-T ON WATER QUALITY AFTER A SPRAYING TREATMENT. U.S. Forest Serv. Res. Note PSW-52, 4 pp. 1964.

Stream pollution has not resulted from removing and chemically spraying vegetation at the bottom of Monroe Canyon on the San Dimas Experimental Forest. The riparian zone and intermediate slopes were hand-sprayed several times with a mixture of 2,4-D and 2,4,5-T herbicide. In another study, brush on side slopes were cut and sprayed. Soil samples taken the first month after treatment showed no traces of herbicides.

Pacific Southwest Forest & Range Expt. Sta., FS, USDA, Berkeley, Calif.

299. Springer, P. F., FISH AND WILDLIFE ASPECTS OF CHEMICAL MOSQUITO CONTROL. Proc. 15th Annu. Meeting N.J. Mosquito Extermin. Assn., 194-203. 1963.

Certain chemicals used for mosquito control can be hazardous to valuable fish and wildlife resources, particularly when these chemicals are applied repeatedly or in large amounts. Findings of laboratory and field studies with standard mosquito control toxicants were summarized under major groups of plant and animal life. Crustaceans, which are closely related to insects, and which contain several commercially important species, were very susceptible to chemical poisoning. Although direct poisoning was the most obvious influence of insecticides, indirect harm can result to higher animals by concentration of chemicals in their passage through food chains or by reduction of important food-chain organisms. Adherence to basic rules will reduce wildlife losses from chemical mosquito control programs.

Coop. Wildlife Res. Unit, S. Dak. State Col., Brookings, S. Dak.

Problems Indirectly Affecting the Application of Soil and Water Conservation Practices

SEE ALSO 116, 128, 141, 255, 279, 298, 299.

300. Shadbolt, C. A., Whiting, F. L., and Lyons, J. M. PERSISTENCE OF MONURON AND NEBURON UNDER SEMI-ARID FIELD CONDITIONS. Weeds 12(4): 304-306. 1964.

Monuron and neburon were applied to a sandy loam soil which was planted to several crops in southern California. Monuron at 2, 4, and 8 lb./A. and neburon at 2 lb./A. were below phytotoxic levels by 12 months. Neburon at 4 lb./A. persisted at phytotoxic levels for over 16 months, and at 8 lb./A. for over 24 months.

Thompson-Hayward Chem. Co., Kansas City 41, Mo.

301. Baechler, R. H., and Roth, H. G. THE DOUBLE-DIFFUSION METHOD OF TREATING WOOD: A REVIEW OF STUDIES. Forest Product J. 171-178. Apr. 1964.

A general review was given of experiments conducted during the past 23 years on the double-diffusion method of treatment wood. Most laboratory work described was done at the U.S. Forest Products Laboratory in Madison, Wis., while a number of the field tests were made in cooperation with other agencies.

The double-diffusion method consists of soaking green wood first in one chemical solution and then in a second solution. The chemicals, being water soluble, diffuse into the free water in the wood, wherein they react with each other to form a relatively insoluble, nonleachable compound toxic to fungi and insects.

Forest Product Lab., FS, USDA, Madison, Wis.

302. Neetzel, J. R. BUILDING BETTER FARM FENCES. U. Minn., Agr. Ext. Serv. Ext. B. 272, 16 pp. rev. 1964.

An illustrated guide was given on building better farm fences. The following steps were given for building good fences:

1. Locate corners, ends, and gates.
2. Choose durable posts—such as treated wood posts—for long service life.
3. Use 3- to 5-inch, 6-1/2- to 7-foot posts for line construction. Use 4- to 6-inch, 8-foot posts for corner and end construction.
4. Use 12- to 16-foot posts on either side of gates.
5. Set permanent posts at corners, ends, and gates.
6. Use a tightly stretched barbed wire between the ends, corners, and gates to build a straight fence.
7. Provide a good foundation for the fence with properly constructed corner and end sections using small treated wood posts.
8. Use a power post driver to set fence posts easily and economically.
9. Use pointed wood posts for easier driving and a better fence.
10. Use the wrap splice for connecting the wire.
11. Don's stretch wire too tightly. Stretch woven wire so as not to remove more than one-fourth of the hump from the horizontal wire. Do not use machinery to stretch barbed wire.

12. Use 1-1/2-inch (or longer) galvanized staples for treated pine posts.
13. Slope staples into the wood against the pull of the wire.
14. Drive staples at a slight angle (not parallel with side of post).
15. Do not drive staples tightly against the wire. The wire should be free to move through them.
16 Remember: fencing is hazardous work. Wear heavy leather gloves to avoid cuts or torn flesh.

Agr. Expt. Serv., U. Minn., St. Paul, Minn., 55101

303. Hill, R. D. CHARACTERISTICS OF SLOW SAND FILTERS FOR POND WATER FILTRATION. Trans. ASAE. 7(3): 294-296, 299, 335. 1964.

A slow sand filter was studied for 3 years under varying conditions in order to gain information on its operational characteristics in the filtration of farm pond water. The following conclusions were made:

1. The top few inches of sand removed the greatest percentage of turbidity and color while the remaining sand removed a small amount.
2. As the turbidity concentration increased, the percentage of turbidity removed by the filter also increased.
3. From the standpoint of design, it was advisable to provide the deepest bed of sand that was both feasible and economical.
4. Schmutzdecke characteristics varied with the type of raw water intake used. The surface intake produced a "decke" mainly of clay and silt while the gravel-barrel and buried-pipe intake produced one high in organic matter. Schmutzdecke thickness varied between 1/32 and 1/8 in. and discolored sand was detected as deep as 8 in.
5. A fiber-glass mat placed on top of the sand filter served as a surface for schmutzdecke development instead of the sand. The mat made the filter easier to clean and resulted in a saving of filter sand. Filter performance was not affected by the mat except in that filter runs were somewhat shorter.
6. In 55 percent of the samples, the slow sand filter reduced the coliform bacteria density to less than 3 MPN/100 ml. The large percentage of samples that still contained coliform bacteria indicated that additional disinfection was needed in order to produce acceptable water.
7. Disinfection of raw water prior to the slow sand filter resulted in longer filter runs and larger volumes of water being treated per run, but did not improve filtration. The large chlorine demand of the filter usually reduced the chlorine residual in only a few inches of sand.
8. There was no appreciable difference in turbidity removal with flow rates varying between 15 and 150 gal. per day per square foot of surface area.
9. Early spring (February, March, and April) was the most critical period for filter operation. During this time turbidity and apparent color were high and the particle size of the suspended matter was small. These characteristics of the raw water resulted in the filter being unable to produce acceptable water.

U.S. Public Health Serv., Robt. A. Taft Sanitary Engin. Cent., Cincinnati, Ohio.

304. Monke, E. J., Wilke, H. R., Laudenschlager, L. G., and Albrecht, K. J. DIATOMACEOUS EARTH FILTRATION OF POND WATER FOR DOMESTIC USE. Trans. ASAE 7(3): 318-320. 1964.

Diatomaceous earth filtration consists of applying a thin layer of mined and graded diatomaceous earth, called "filter aid," on a porous supporting element and then passing the water to be cleansed through this layer. This layer of diatomaceous earth, called "precoat" or "filter cake", then retains the suspended solids in the water and protects the filter element from becoming clogged. The filter element itself acts as a check filter since the element must be constructed with exposed pore sizes which are small enough to allow the filter aid to bridge across the openings. During filtration, a small amount of filter aid can be added continuously or periodically to the influent water. This filter aid, now called body feed, tends to keep the face of the filter cake porous reducing the rate of pressure build-up and thus increasing the length of a given filtration cycle. When a limiting pressure has been reached, the clogged filter cake is washed away and a new layer may then be placed on the supporting elements for the next filter run.

In a study of diatomaceous earth filtration of pond water for domestic use, the authors concluded that:

1. The intricate structure of diatomaceous silica made this material highly desirable for the filtration of raw water.
2. Diatomite filters when correctly operated reduced turbidity of pond water to acceptable drinking water standards.
3. Diatomite filters were capable of removing algae from pond water and reducing the iron and manganese content of the water.
4. Pretreatment was generally not necessary with diatomaceous earth filtration. Some pathogenic chlorine-resistant organisms which were able to pass through slow sand filters were removed by the diatomite filter.
5. Successful operation of a diatomite filter was dependent on proper techniques which often were time consuming. Many of the filtration conditions, however, were amenable to control operations.
6. The vacuum-type diatomite filter was a better type of filter than the pressure-type for the production of potable water. It was constructed of lightweight materials, required less labor to operate, and was easier to control.

Purdue U., Lafayette, Ind., 47907

Radioactive Fallout

305. Burton, J. D., Guenther, W. B., and Owen, H. M. PROFILE OF NATURAL RADIOACTIVITY IN HARTSELLS LOAM. Soil Sci. Soc. Amer. Proc. 28(4): 500-501. 1964.

During the summer of 1961, bulk samples at 4-inch intervals to a 30-inch depth were collected at 15 random locations within an apparently uniform single acre of forest soil (Hartsells loam) under oak-hickory sawtimber on the Cumerland Plateau in Tennessee. Net radio-activity, total potassium content, and mechanical fractions were determined in the laboratory. After samples were stored in sealed containers for 7 days, activity was counted again and was found to be increased. Linear regressions of initial activity on silt-plus-clay and on K, K on silt-plus-clay, and 7-day activity on clay, on K, and on 1-day activity were highly significant. Distributions of K, and of initial activity in the soil profile were more closely related to the profile of total fines than to the clay curve. Initial activity was believed to be due largely to K-40, but activity gain during storage was probably due to daughters of U-238.

Southern Forest Expt. Sta., FS, USDA, New Orleans, La.

306. LaCroix, J. D. RADIOSENSITIVITY OF JACK PINE SEED TO COBALT-60. Forest Sci. 10(3): 293-295. 1964.

Following exposure of Pinus banksiana Lamb. seeds to varying doses of Co-60, germination counts, seedling measurements, and morphological effects were recorded. Percentage and rate of germination of the seed was reduced following irradiation with Co-60, particularly with dosages exceeding 9,000 r./hr. At the higher dosages, morphological effects included: Inhibited growth; thickening of the hypocotyl; and a swelling of the seed contents.

U. Detroit, Detroit, Mich.

307. Zeigler, T. R., Leach, R. M., Jr., Scott, M. L., Huegin, F., McEvoy, R. K., and Strain, W. H. EFFECT OF ZINC NUTRITION UPON UPTAKE AND RETENTION OF ZINC-65 IN THE CHICK. J. Nutr. 82(4): 489-494. 1964.

The metabolism of zinc was investigated using Zn-65 retention in the tissues of 4-week-old cockerels fed either zinc-deficient or zinc-sufficient diets. All tissues from the deficient chicks retained radiozinc to a much greater degree than controls, with the activity increasing greatly during a 32-hour study period. Correlation coefficients derived by computer analysis showed that Zn-65 retention in red blood cells had a high positive correlation with all tissues examined, especially for the sufficient group. Plasma retention exhibited a low negative correlation for both dietary supplement groups. Stable zinc analyses demonstrated that most organs remain constant in zinc content in deficiency states; only bone, liver, and duodenum showed a lower stable zinc content in deficiency than in sufficiency.

A zinc deficiency syndrome occurring elsewhere in human males, characterized by dwarfism, rough skin, delayed epiphyseal closure, hypogonadism, and failure in the development of secondary sex characteristics, was compared with the deficiency observed in these cockerels.

The observations that uptake and retention of radioactive zinc is markedly greater in zinc deficient animals, as compared with that which occurs in those receiving adequate dietary zinc, have important implications, not only in normal nutrition, but also in terms of radioactive Zn-65 from nuclear fission.

Conewago Feeds, Gardners, Pa.

308. Brungs, W. A., Jr. THE RELATIVE DISTRIBUTION OF MULTIPLE RADIO-NUCLIDES IN A FRESH-WATER POND. Dissert. Absts., Vol. 24, No. 7, P. 3023. 1963.

A plastic-lined pond containing 30,000 gallons of spring water and a sand substrate was used for this study. The test organisms were carp, Cyprinus carpio; bluegills, (Lepomis macrochius;) snails, Vivipara malleatus; tadpoles of the bullfrog, Rana catesbiana; and two species of clams, Anodonta grandis, a thin-shelled species, and Lampsilis radiata siloquoidea, a thick-shelled species. Water and substrate samples were also collected and analyzed.

Four millicuries each of cobalt-60, zinc-65, strontium-85, and cesium-137 were added to the pond water several weeks after the test organisms had been introduced. Samples for baseline radio-logical data were collected several days before the start of the experiment, after which 10 complete sets of samples were collected over an 80-day period.

During the experiment, numerous chemical, physical, and biological analyses were performed on the experiment pond water and also on a control pond.

There was an initial rapid loss of cobalt-60, zinc-65, and cesium-137 from solution. Cobalt-60 and zinc-65 were becoming associated with the suspended solids and cesium-137 was absorbed onto the bottom sediments. Strontium-85 was gradually removed from solution. Only 8 percent of the cobalt-60, 4 percent of the zinc-65, and 5 percent of the cesium-137 remained in solution after 4 days. Sixty-four percent of the strontium-85 was in solution at this time.

More zinc-65 was found in biological samples than any of the other test radionuclides except in some hard parts fractions such as shell and bone in which strontium-85 activities were generally higher. The primary consumers, carp, snails, tadpoles, and clams, accumulated more of each radionuclide than did the predatory bluegill. In general, soft parts rapidly accumulated more activity than the hard parts but gradually lost it as radionuclide concentrations in the water decreased. Clam and snail shells and fish bone generally accumulated zinc-65 and strontium-85 for almost the duration of the experiment.

Carp, snails, and clams remaining after the final sampling from the pond were placed in continuously replenished, uncontaiminated water for 3 weeks, but no detectable radionuclide loss was observed. During this time, the water temperature was low, about 15° C. less than during the experiment, and the metabolic activity of these test organisms was greatly reduced.

Young clams and snails accumulated more zinc-65 and strontium-85 than did adult individuals of these two groups. However, strontium-85 concentrations in the soft parts of clams were higher in the adults.

Ohio State U., Columbus, Ohio.

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